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ASPECTS OF PHYLOGENESIS IN HOLOMETABOLOUS INSECTS AS RELATED TO DATA ON METAMORPHOSIS HORMONES[1]

V. NOVAK

Data from various branches of physiology and especially from the branch known as developmental mechanics have been used in the past in a completely unfounded way by many investigators as arguments against the Darwinian concept of natural selection and even against the idea of evolution as a whole. Although the number of such investigators is small and ever decreasing, it remains indisputable that far less attention is paid to the thorough evaluation of data from the various morphological and paleontological data. Nevertheless, it is precisely these data that are of such great importance to an understanding of the existence of a species and are often decisive for synthesis. This is largely true of insect metamorphosis hormones when various aspects of the question are being considered (Hanstroem, Scharrer, Cazal, Shteynberg et al.).

On the occasion of two such important anniversaries in progressive biology as the hundredth anniversary of the publication of Darwin's celebrated work The Origin of Species by Natural Selection and the hundred and fiftieth anniversary of its author's birth, it seems to me not out of place to attempt, even in the most general terms, to evaluate the importance of the contribution made by data on metamorphosis hormones in insects to solution of the problem of the phylogenesis of metamorphosis, and thus also to the problem of the origin of the whole division of holometabolous insects (the Pterygota in general) and to bring these data in line with the most important contemporary views on the question. Although my own 'gradient-factor theory of metamorphosis' was initially arrived at by deduction and has only subsequently been confirmed in certain respects by a great deal of later experimental data from our group and other workers, it nevertheless provides both a moral basis and a useful guide line for this attempt. I must therefore recall at least the most important aspects of this concept.

The Gradient-Factor Theory

The attempt to create a general concept of metamorphosis was based on our studies on the nonspecificity between orders of the incretion of the corpora allata, the juvenile hormone (JH) or neotenin (Novak, 1951a). This proof has since been confirmed and extended to other insect orders by the experiments of other investigators (Wigglesworth, 1951, 1953; Piepho, 1951, 1955), and is also fully applicable, as we know now, to two other metamorphosis hormones — the activation hormone (AH), manufactured by the neurosecretory cells of the brain, and the moulting hormone, or ecdyson, secreted by the prothoracic glands. The author was prompted by the discovery that the most important of the metamorphosis hormones was nonspecific to attempt to correlate all the then known data concerning the effect of metamorphosis hormones with morphological and histological data. The theory thus developed was based on the as yet hypothetical assumption of the existence of a growth factor of the type of desmohormone, called the gradient-factor (GF). One of the properties of the gradient-factor is its gradual inactivation in the most diverse parts of the insect body, where morphogenesis from the embryo to the imago is taking place. The most important points of the gradient-factor theory of metamorphosis can be briefly summarized as follows:

1. Insect metamorphosis is only the continuation and final link in the uneven (allometric growth of the embryonic stage, that is temporarily interrupted by a larval stage of even growth, in the course of which body form is not changed.

2. The even growth typical of the larval stage of embryonic development in insects is a result of the effect of the juvenile hormone (JH), the incretion of the corpora allata (Fig. 1). Like the anterior hypophyseal hormone of vertebrates, this hormone is a growth factor, and since it is a substance that is carried by the hemolymph it has an obligatory effect on all parts of the body. Its effect is, of course, only manifested on those parts of the body (tissues, cells or parts of cells) which have lost the capacity for further growth during the preceding stage in ontogenetic development and which would be subjected to partial or total histolysis in the absence of JH. Under the influence of JH these parts of the body, which can be termed larval, are activated to further growth, the rate of which is equal to that of the remaining, imaginal parts of the body. As a result of this, the uneven growth of the embryonic stage is changed to even growth without change of form, which is a typical feature of the whole larval stage of insect development.

3. The only difference of general significance between the larval and the imaginal parts of the body is that the former are not capable of growth in the absence of JH. According to the gradient-factor theory this is due to the absence of a definite substance (or group of substances) of the type of desmohormone, that is essential for growth and has been called the gradient-factor (Novak, 1951a, 1951b, 1956, 1959), since its distribution in the organism in the course of development is the cause for the development of gradients of uneven growth. Although the existence of the gradient-factor is still largely hypothetical, the correctness of the view is demonstrated by certain concrete results from our experiments on the influence of JH on the morphogenesis of the bug Oncopeltus fasciatus Dal. This species is a very suitable subject for such studies, since the black stained imaginal parts of the body are markedly different from the red larval parts.

4. From the nature of its effect on growth, the gradient-factor can be replaced by the juvenile hormone. Thus, when the action of JH is prolonged at a stage when its function would already have ceased under normal conditions (i.e., when active corpora allata are implanted in the final larval stage) full growth of the larval parts of the body is correspondingly extended. Their growth should cease, owing to lack of the gradient-factor, but additional moultings occur under the influence of JH and larvae of greater size develop. When the effect of JH is weak or only operative for a limited period, forms that are transitional between the larva and the imago develop. On the other hand, removal of the source of JH in young larvae (by decapitation, extirpation of the corpora allata and also by ligation) is followed by a more rapid termination of even growth, which leads to premature metamorphosis and the formation of dwarf forms.

5. JH begins to operate at the close of embryonic development, soon after the formation of the corpora allata. Even growth begins from this moment and the form of the developing embryo seems to be fixed at the stage which it had reached by this time and does not change right down to the final larval stage, when, as a result of lack of JH, regular growth is replaced by irregular growth and the onset of metamorphosis. It follows from this that the whole larval period, which is marked by even growth, is a direct consequence of the action of JH.

6. A definite minimum concentration of JH in the hemolymph is necessary to induce even growth of the whole body, i.e., to stimulate the growth of the larval parts of the body. Owing however to the fact that the hormone dissolved in the hemolymph is continually secreted through the Malpighian tubules (Bounhiol, 1953), the concentration of the hormone

[1] Paper presented to a general session of the All-Union Entomological Society in Leningrad on 14 January 1959.

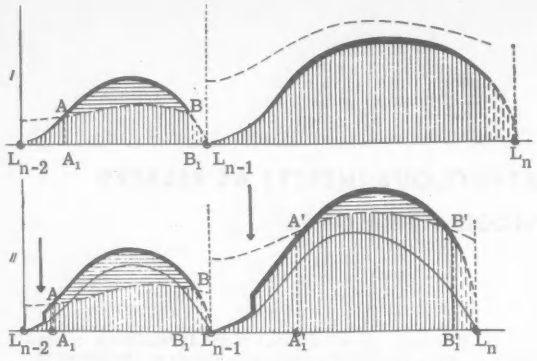

Fig. 1 - Diagram of the influence of the juvenile hormone (JH) in changing uneven growth (vertical shading) to even growth (horizontal shading) in the penultimate and ultimate larval stages under normal conditions (I) and after implantation of the corpora allata at the beginning of the growth period (II). X-axis — time, Y-axis — concentration of juvenile hormone in the hemolymph. L_{n-2} - L_{n-1} — the penultimate larval stage. L_{n-1} - L_n — ultimate larval stage. Thick line — actual JH concentration in the given stage; broken line — minimum operative JH concentration in the given stage; thin line — assumed normal concentration of JH. A_1A — moment at which the minimum operative concentration of JH is attained in the penultimate and $A_1'A_1'$ in the ultimate larval stage; B_1B — moment at which the JH concentration falls below the operative minimum in the penultimate and $B_1'B_1'$ in the ultimate larval stage.

falls below the operational minimum if the corpora allata cease to secrete it. This weakening always occurs in a moulting period, when, owing to the retarded activity of all the organs, the corpora allata also cease to function almost entirely. At the beginning, therefore, of each period (stage) between moultings a definite time must always elapse before the JH concentration again rises to the level necessary. During this time, as in the moulting period, only those parts of the body which have their own gradient-factor, i.e., the imaginal parts (the imaginal discs in Holometabolic insects) are able to grow. Growth in each moulting stage therefore consists of an initial period of uneven growth, when only the imaginal parts of the body grow, and of a subsequent period of even growth of the whole body.

7. The rate of JH secretion and, therefore, the time required for a minimum operative concentration of JH to accumulate depends under equal conditions on the ratio between the size (volume) of the corpora allata and the amount (volume) of the hemolymph or of the whole body, and also on the ratio between the surface of the corpora allata (as the diffusion area of the hormone) and the volume of the hemolymph. It has been established from measurement of growth in the volume of the corpora allata and in body volume in 18 species of insects belonging to 8 different orders (Novak, 1954) that the corpora allata always grow more slowly than body volume. In each successive instar, therefore, there is a relative retardation in the secretion of JH and the minimum effective level for the JH concentration in the hemolymph is reached ever later. In each subsequent stage, therefore, the initial period of uneven growth is extended at the expense of the later period of even growth. Thus, a stage is ultimately reached in which the minimum effective concentration of JH is not attained in one of the larval stages before its further secretion is once again inhibited by the onset of moulting. In this case the larval parts of the body are not activated, their further growth therefore ceases and there may be partial (Heterometabola) or total (Holometabola) histolysis. As a result, the stage at which metamorphosis occurs is the last larval stage. Since the prothoracic glands cease to function as larval parts of the body and stop secreting moulting hormone, the next moulting does not occur. Moulting does not therefore occur in adult metamorphic insects (unlike the Crustacea and the Apterygota).

8. Whilst the larval parts of the body are growing, the imaginal parts only receive an amount of the total nutrients at the organism's disposal corresponding to the ratio between their volume and the volume of the body. When, however, the portion of the larval parts is greatly reduced owing to cessation of their further growth, the portion of the imaginal parts is correspondingly increased and their growth is correspondingly accelerated (other conditions being equal). This explains the great acceleration in the growth rate of the imaginal parts of the body (the imaginal discs in holometabolous insects) in the period of metamorphosis by comparison with their growth in the larval period. The total amount of nutrients available to construct the imaginal parts of the body is further increased by histolysis of the larval parts of the body.

9. Growth and the moultings related to it throughout the whole of the postembryonic development of insects are due to the presence, in addition to JH, of two further hormones: 1) the activation hormone (AH), that originates in the neurosecretory cells of the brain (first discovered by Kopec in 1922 and described in detail by Wigglesworth in 1934 in Rhodnius prolixus as the 'moulting hormone'; 2) the moulting hormone (MH), that is produced by the prothoracid glands and has sometimes less aptly been called the growth and differentiation hormone and the growth or pupation hormone (Fukuda, 1942; Williams, 1946, 1947; chemically isolated by Butenandt and Karlson, 1954). The activation hormone, which reaches an effective concentration in each stage earlier than the other three hormones named, is essential to give the prothoracic glands the capacity to secrete the moulting hormone. It is therefore also called the thoracotrophic hormone. It is also essential to the growth of the ovaries (Thomsen, 1952 — Calliphora erythrocephala Meig.) and is also probably responsible for a number of other functions in the organism. The second of these hormones, the moulting hormone, is mainly essential to the moulting process. Thus, it is also obliquely essential to growth. In addition, it is also a direct condition of growth. A temporary interruption in the secretion of the activation hormone is an internal cause of pupal and larval diapause. Both hormones (AH and MH) operate throughout postembryonic development and do not affect whether growth is uneven (differentiation) or even (larval growth). This latter is only dependent on the presence of JH. There is therefore no foundation for describing AH + MH (Scharrer, 1948) or MH alone (Williams, 1952) as 'the growth and differentiation hormone'.

Although the existence of the gradient-factor is still only hypothetical, the assumption of its existence can be combined with the general concept of metamorphosis to give a satisfactory explanation of many actual and as yet unresolved problems. This is, in itself, an additional proof of the correctness of the hypothesis. It makes possible a re-examination of the origin and development of metamorphosis throughout the phylogenetic development of insects and simultaneously provides new criteria for re-evaluating the countless and often mutually exclusive theories of Pterygotan phylogenesis, to a critical examination of which we must proceed.

The Berlese-Yezhikov Theory

Before the first works on hormones were published all hypotheses concerning the origins of metamorphosis were based on morphological and histological data. One of the first serious attempts to explain the nature of metamorphosis and its development from the data then available was a work by Berlese (1913). Berlese based his theory on old data, originating with Harvey (1651) on the similarity between the insect larva and embryo on the one hand and the pupa of the Holometabola and the nymph of the Heterometabola on the other. The main idea in Berlese's theory was that the larva of the Holometabola had arisen by a shift in eclosion to earlier stages in embryonic development by comparison with what happened in the Apterygota and the Heterometabola (Fig. 2). Since the larva of the Holometabola was much more different from the imago than the larva of the Heterometabola, there had to be more profound morphological changes at the close of postembryonic development. This led to the development of a new morphological stage, i.e., the pupa. According to this view, insects with incomplete metamorphosis emerge from the egg at a later stage of embryonic development, known as the oligopod stage, while insects with complete metamorphosis emerge at an earlier, polypod stage, and some of them, such as certain parasitic Hymenoptera, at the even earlier protopod stage.

Subsequent examination and development of Berlese's views is associated with the name of Yezhikov, and it has therefore become customary to refer to their theory as the Berlese-Yezhikov theory. Yezhikov's main contribution (1929, 1936, 1940) was that he pointed out the existing connection between the morphological phase at which eclosion from the egg occurred and the amount of yolk in the egg. The less yolk there is in the egg, the earlier will be the

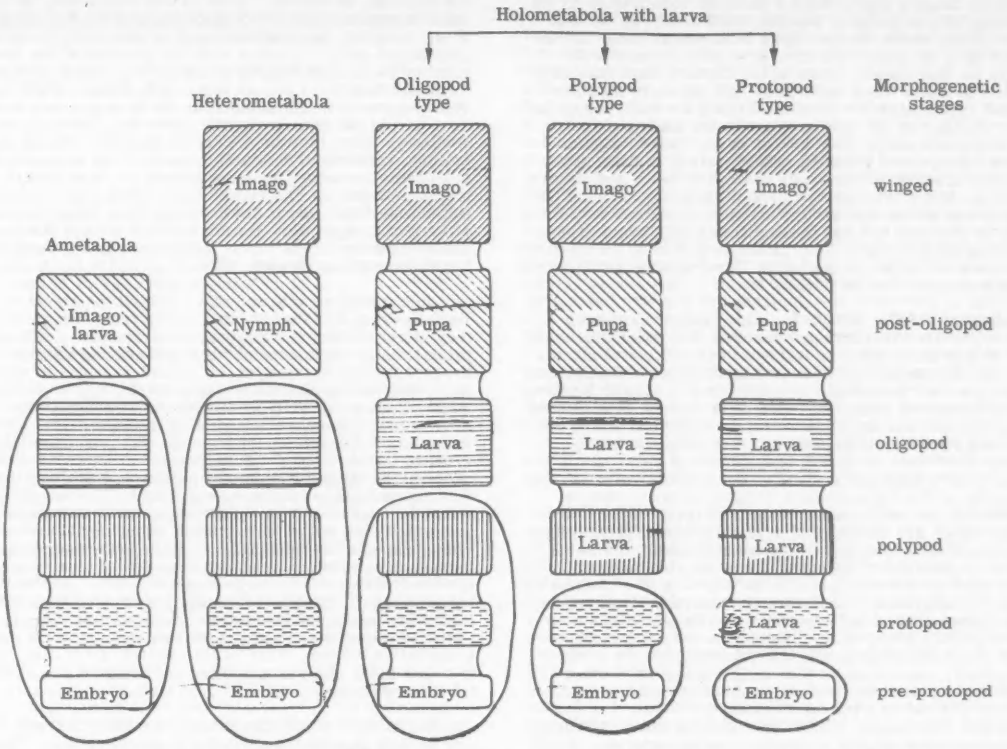

Fig. 2. - Diagram of the interactions between morphological stages of development and ontogenetic position according to the Berelese-Yezhikov theory. Stages that occur within the ootheca are circled round.

stage of embryonic morphological development at which the given larva emerges from the egg. Thus, while the Apterygota and the Heterometabola, the larvae of which are ecloded in the late oligopod stage, have eggs with a high yolk content, there is very little yolk in the eggs of the Holometabola, and the eggs are almost devoid of trophic yolk in those of them which are ecloded at the protopod stage. Yezhikov also pointed out that it was essential to draw a distinction between the early oligopod stage, at which the larvae of many insects with complete metamorphosis are ecloded (including the Coleoptera, and certain Hymenoptera and Diptera, for example) and the late oligopod stage at which eclosion of the nymphs of the Heterometabola occurs.

Objections to the Berlese-Yezhikov Theory

Many objections have recently been raised against the Berlese-Yezhikov theory. Thus, for example, Kozhanchikov (1946) has pointed out that certain histological and physiological features of the pupal stage, and especially the markedly differing type of metabolism (U-shaped oxygen demand curve) and also the features of hormonal regulation (the pupal stage is marked by the absence of the juvenile hormone) enables one to conclude that the pupa is a special, independent stage in the development of the Holometabola, which cannot be compared with any other stage in the development of other insects. However, a more detailed and profound study of insect hormones leads us to the conclusion that all these differences are more properly quantitative in nature and do not justify such conclusions. And if we are in fact dealing with more fundamental differences, such as, for example, the existence of two stages at the close of postembryonic development in the Holometabola, marked by the absence of JH (the last larval instar and the pupa), instead of one such period between moultings, as in the Heterometabola, this can be explained by slight variations in the extent of the metamorphosis determined by the hormones, which are of little importance from the phylogenetic point of view.

Snodgrass (1954) criticizes the Berlese-Yezhikov theory on grounds similar to those in Kozhanchikov's criticism. His objections are, however, only directed against one of Yezhikov's unhappy formulations, that the larva is only a free living embryo. This objection, however, becomes superfluous if we replace the term 'embryo' by the more accurate expression 'morphological or morphogenetic stage', which is reached by the Exopterygota at an early stage in embryonic development. Although this formal inaccuracy by Yezhikov does not lead to any actual error, the same cannot be said of a similar formal inaccuracy of which Snodgrass is guilty when he criticizes Yezhikov's slightly inaccurate conclusion that the pupa is a result of the coalescence of all the nymphal stages. Snodgrass states that "the pupa itself sufficiently refutes this theory; it gives no evidence of being a composite stadium since its external structure once formed remains unchanged." Here Snodgrass is unquestionably guilty of the same inaccuracy for which he reproached Yezhikov, since he confuses the stadium of morphological development with its adaptation to the living conditions found in a given insect group. But whereas with Yezhikov this slight formal inaccuracy does not conflict with a correct definition of the essence of the problem, the similar inaccuracy by Snodgrass leads to absolutely incorrect conclusions. Although the process of moulting is intimately connected with morphological development, provides the conditions for it and also influences it obliquely, it is a completely independent process. In the given case, therefore, it is not of fundamental importance for solution of the problem of the morphological interrelationships between the pupa and the nymph, and from the point of view of phylogenesis it is, as I have already pointed out, a secondary and unessential property.

Hinton (1948, 1955) had different objections to the Berlese-Yezhikov theory. He found from his own studies that the prolegs of the larvae of the Panorpoid complex (the orders Trichoptera, Mecoptera, Lepidoptera, Siphonaptera and Diptera) were secondary formations that were not homologous to the abdominal appendages of the polypod stage, as is assumed by the Berlese-Yezhikov theory, and even not homologous to each other. In addition, since in Hinton's view all insect groups in which the larvae have prolegs have developed from groups in which the larvae do not, he considers that the fundamental hypothesis of the Berlese-Yezhikov theory contradicts Dollo's well known principle. I do not wish here to discuss the correctness of Hinton's morphological data, which

are in their totality undoubtedly a valuable contribution to the morphology of this group of insects; but I cannot agree with the conclusions which Hinton draws from them. Does not the very fact that, as Hinton asserts, prolegs developed independently no less than 27 times in the Diptera show that there must here be some inner connection, all the more so since abdominal appendages are developed in all the embryos of the insects, whether or not they are lost by the larvae at later stages in phylogenesis. It is in fact impossible to say that they have disappeared from the ontogenesis of a given group, as would be assumed on the basis of Dollo's law. And if here, despite this, there is an exception to Dollo's law, it must be noted that similar exceptions are already known. It would after all be possible to treat the fact that many insect groups have well developed trunk legs, although they have disappeared without trace from the larvae (many Hymenoptera and Diptera), as being a contradiction of Dollo's law.

Zakhvatkin (1953a, 1953b) has also raised various objections to the Berlese-Yezhikov theory. The most important of these can be formulated as follows: various larval attributes of the Holometabola, such as homonomous metamerism, the primitive structure of the mouth parts and simple stemmae instead of compound eyes, etc., are in fact more reminiscent of the larvae than the embryos of the Heterometabola and do not have any specific distinguishing embryonic attributes. Zakhvatkin therefore considers that a reverse relationship takes place here and that, instead of the disembryonization of the larvae of the Holometabola (Oligoneoptera), what is taking place is the embryonization of the larvae of the Heterometabola, which are correspondingly ecloded at a later stage in morphological development. Zakhvatkin does, of course, allow that the process of disembryonization also occurs to a limited extent in, for example, the protopod larvae of certain parasitic Hymenoptera. According to Martynov, Zakhvatkin is seeking ancestors of the contemporary Holometabola near the contemporary group of the Paleoptera and compares the larvae of the Holometabola with the youngest nymphs of the Ephemeroptera, which is the first active stage after emergence from the prelarval cuticle. In mentioning Martynov, it is impossible not to touch on his proposed division of the insect orders (Martynov, 1938). New data on the morphology of the retrocerebral glands in insects, which were not, of course, fully available to Martynov, confirm the correctness of his views (see, for example, Cazal, 1948). This is not however, an argument in favor of Zakhvatkin's views on embryonization. There is no need to give a detailed proof of the incorrectness of the hypothesis already advanced by Handlirsch that the ancestors of the contemporary Holometabola should be sought among insect groups the larvae of which lived in water. Schulz showed long ago from an extremely detailed study of the tracheal system of Lepisma that this view was untenable, and it has recently been rejected by Gilyarov (1949) and Sharov (1953). Objections to the concept of disembryonization are based on a similar misunderstanding as in the case of Kozhanchikov and Snodgrass. There is a confusion between the level of morphological development of the corresponding stage and its adaptations to the specific conditions of life. The latter also include everything associated with life within the ootheca, and it is therefore impossible to expect, as Zakhvatkin requires, that they will also be encountered in free living forms. Moreover, disembryonization is only a special case of the widespread phenomenon of neoteinia, which is one of the main forms of phylogenetic progress and which is fully in agreement with Haeckel's biogenetic law (we note as an example the large dimensions of the central nervous system in relation to the dimensions of the whole body in larvae of the first instars by comparison with older larvae). This also holds in relation to Scharrer's criticisms (1948), who considers that those features of the larvae of the Holometabola which Berlese and Yezhikov treat as being embryonic are in fact inherited from the corresponding stadia of the myriapod-like ancestors of contemporary insects. It is impossible to accept Sharov's view that the concept of the transition of the embryo to the larval form of life is in no way simpler than the transition of a specialized parasite to a free mode of life. On the contrary, it is very simple from the point of view of data on metamorphosis hormones, and from the point of view of phylogenesis it only requires slight changes of a phylogenetic nature. Similar facts can be opposed to the objections of Shteynberg (1956a, 1956b, 1956c, 1957), who, however, is superior to the previous authors in that he appends a review of data on metamorphosis hormones to his conclusions. One can fully agree with Shteynberg when he emphasizes the importance of embryonization to the development of the Insecta. This significance clearly flows from the fact that the morphological stage corresponding to the nauplius of crustaceans, in which mites and ticks remain with slight variations right down to the adult state, has been shifted deep into embryogenesis in the majority of insects. This can be confirmed, at least for the Apterygota and the Exopterygota and for the polypod stage. It is, however, impossible to agree with Shteynberg's juxtaposition of embryonization with the process of the development of the Endopterygota in conformity with the Berlese-Yezhikov theory. I am not inclined to treat a shift towards embryogenesis in the moment at which organs are formed as a part of the embryonization process. This is, on the contrary, more likely to be one of the after effects of disembryonization and the earlier onset of the action of metamorphosis hormones associated with it. It should be remembered that the imaginal discs are fully determined in the egg before blastulation, as emerges from experiments in which insect eggs were irradiated with X-rays (Geigy, 1931) and as clearly occurs in the Heterometabola as well as in the Holometabola (Seidel, 1924).

In conclusion, one can state that all the objections to the Berlese-Yezhikov theory cited suffer from one general fault: they attach too much significance to changes in physiological properties in the course of phylogenesis and underestimate the morphological changes. It should be borne in mind that such basic morphological changes as development from one stage of morphogenesis to another correspond within the system to a difference of a rank of a whole class, as occurs in the case of development from the polypod stage (Myriapoda) to the oligopod stage (Apterygota), or these differences even attain the rank of a phylum in development from the protopod stage (rotifers — trochophore — nauplius — mites and ticks) to the polypod stage. A development of this type is the result of a gradual accumulation of countless single changes of mutation type, and these changes are therefore very important from the point of view of phylogenesis. Changes of a physiological nature, on the other hand, many of which are of much greater significance for the life of the insect, and therefore for selection, may be the result of a single genetic change and are often of a purely quantitative nature. This is also shown, inter alia, by the fact that these changes are often encountered as developmental abnormalities.

It can be said that the actual objections of these authors are wholely directed against their own mistakes. These mistakes arise from the fact that all the authors are trying to prove the embryonic nature of the larvae of the Holometabola, by stressing isolated primitive attributes (short antennae with a small number of segments, simple instead of compound eyes, primitive mouth parts, primitive legs, etc.). All this is, on the one hand, all these structural features are not essential to determine to which of the three stadia of morphological development the larva belongs (protopod, oligopod and polypod), which can be easily established from the presence or absence of abdominal appendages, while on the other hand these morphological features undergo changes of the type of secondary adaptation. Zakhvatkin (1953a, 1953b) is therefore undoubtedly correct when he points out that these properties of larvae do not fully determine their embryonic nature. If one cannot treat the presence of these properties as a proof of the embryonic nature of a larva, it is also incorrect for the same reasons to treat them as evidence against the embryonic nature of the larva. The remaining data, despite this formal defect, also unquestionably support Yezhikov's views. Gilyarov (1949) came to similar conclusions from quite different ecological data. He writes, although without any more detailed explanation, that "my hypothesis on the ecological paths of insect development corresponds both to Kozhanchikov's latest phylogenetic and physiological views (1946) and to Yezhikov's concepts (1929, etc.) — concepts which at first sight seem to contradict each other." This, as we shall see, can be more correctly applied to the theory here set out.

Wigglesworth (1954a, 1954b) rejects the Berlese-Yezhikov theory from a slightly different point of view and opposes it by his own concept, according to which metamorphosis is only a special case of polymorphism. In his opinion, every polymorphic organism, including insects, contains within it the potentialities for all its different forms. Which of the existing possibilities will be realized in the course of development is conditioned, on the one hand, by genetic make up and, on the other, by definite circumstances (the predominating conditions of the external environment). Polymorphism in zoology is the term applied to the existence of different final or adult forms in one species. Wigglesworth, on the other hand, uses the term polymorphism to denote separate successive stages in morphological development and considers that there are no basic distinctions between these two types of polymorphism (in the broad sense).

Without engaging in a criticism of Wiggleworth's views,

it can at least be noted that his data in no case contradict the fundamentals of the Berlese-Yezhikov theory.

It is not possible in this article to deal with a number of other attempts to explain the origin and essence of metamorphosis, based on a one-sided and often extremely erroneous understanding of isolated data. This applies to the various hypotheses concerning the causes of inhibition in the growth of the imaginal discs, theories of tissue determination and competence, and various partial hormonal theories. All these theories suffer from contradictions of the same type as the concepts already mentioned. On the other hand, it should be stressed that the majority of them have a correct materialist nucleus which, if cleansed of incorrect conclusions and set in a dialectical relationship with other data, is an essential component of the ultimate synthesis.

The Berlese-Yezhikov Theory in the Light of the Hormonal Nature of Metamorphosis

As already noted, all the phenomena associated with metamorphosis, except secondary adaptations, are the essential results of the action of JH and follow naturally from the manner of its action. It is essential to remember that the basic feature that distinguishes insects which undergo metamorphosis from the Apterygota and other arthropods is not the change in body form itself, in as much as this occurs in all multicellular organisms largely or wholly in the embryonic period in some cases and to a greater or lesser extent in the postembryonic period in others. The feature of the morphological development of insects that undergo metamorphosis is the existence of a larval period of even growth in which differentiation is temporarily suppressed. There is a connection between this and the fact that the corpora allata are only found, with slight exceptions (the Japygidae) in holometabolous insects.

If one takes into account that JH fixes the stage of morphological development from the very onset of its operation, i.e., from the end of the embryonic period, by causing uneven growth to be replaced by even growth, it is impossible not to see the explanation of the function of JH that flows from the gradient-factor theory as a brilliant confirmation of the Berlese-Yezhikov theory, which is based solely on observation and comparison. These data remove the foundation for all the doubts concerning the correctness and significance of this theory that have been expressed. There is full justification for stating that when it has been augmented with new data on the metamorphosis hormones, this theory will provide a solid foundation for solving the problem of the origin and development of metamorphosis in insects.

It is highly probable that all three stages which Berlese calls protopod, polypod and oligopod, and which are also found, as Sharov has recently demonstrated (1953, 1957) in the contemporary Thysanura, occurred in the embryonic development of any group of the initial Apterygota. It may have happened that, on reappearing, JH began to affect one of the stages, most probably initially the last of them. As a result of this, insects with partial metamorphosis, thus corresponding to the most primitive representatives of the contemporary Heterometabola, developed from a definite group of Paleozoic apterous insects, which had developed without metamorphosis like the contemporary Apterygota.

From the morphological point of view insects that undergo metamorphosis (the Pterygota) are known to have two pairs of wings in the adult insect, the winged stage being developed by a typical epigenesis. This means that the existence of wings is intimately phylogenetically connected with metamorphosis and, consequently, with the existence of the corpora allata. It clearly follows from the general structure of insect wings that only a shift in morphological growth at the very end of postembryonic development, due to the action of JH, created the conditions for their formation, that would be difficult to bring about in the embryonic period. It follows from this that the development of the juvenile hormone stands in a direct causal relationship to the development of wings. This corresponds to the fact that in the course of phylogenesis the corpora allata slightly precede the development of wings (the Japygidae).

Arising from all that has been said, one can see the great significance of the development of JH for natural selection in the course of phylogenesis in the Pterygota. The question arises as to how JH appeared in the corpora allata of insects without metamorphosis (the Paleozoic Apterygota). In this connection we shall have to be satisfied for the moment with a more or less convincing hypothesis based on the correctness of the assumption that the gradient-factor exists. Bearing in mind that JH is similar in effect and may therefore be chemically akin to the hypothetical gradient-factor, which is undoubtedly older phylogenetically, it is not difficult to imagine the most likely ways in which JH could have developed. Paleontological data show that the first insects to undergo metamorphosis arose from the paleozoic Ametabola, approximately in the second half of the Paleozoic era, at some point at the beginning of the Carboniferous period. It is easy to imagine that one of the biochemical changes to occur in the organism of insects that were beginning to penetrate into the warm Carboniferous swamps in which the vegetation was rich and the conditions for their development were exceptionally favorable, was a slight hereditary variation in the gradient-factor molecule in the reformed corpora allata, as a result of which desmohormone, i.e., a substance associated with the cell plasma, was converted to lyohormone dissolved in the hemolymph. This was a decisive step for the development of a vast contemporary group of insects, since there is no reason to suppose from the available data that there are any further distinctions between JH and the gradient-factor. The adenose epithelium of the twin protuberance of the ectoderm at the boundary between the mandibular and maxillary plates, that is profusely washed by the hemolymph that emerges at these points from the dorsal aorta into the head cavity, was therefore, probably, the most suitable site for the development of the new hormone.

The appearance of JH as a material factor that assisted in protein synthesis, and was responsible for it in the absence of the gradient-factor, and that may also have affected other metabolic processes, exerted great influence on the acceleration of growth from the very beginning of its operation and, probably, even before this effect began to be revealed morphologically. It thus undoubtedly helped to accelerate further the development of the group, which was, in any case, already greatly stimulated by the highly favorable living conditions of the Carboniferous climate. These two factors, optimum conditions and the presence of JH, were undoubtedly the main antecedents of the great development in the newly reappeared Pterygota that occurred at that time. There is every reason to consider that the development of JH in the newly reformed corpora allata was as important for the Insecta as was the development of the hypophyseal and thyroid hormones to the vertebrates, of homothermy to birds and mammals and the appearance of viviparity for the development of the mammals. In other words, it was undoubtedly apomorphosis in Severtsov's sense.

The existing differences between the divisions of the Heterometabola (Exopterygota) and the Holometabola (Endopterygota) in relation to the level of morphological changes in metamorphosis are in full agreement with the hypothesis. While the newly redeveloped corpora allata were still not fully developed (approximately the same as, for example, in the contemporary Phasmida) it took a long time for the minimum effective concentration of JH to be reached in the hemolymph and the insects only underwent eclosion at the oligopod stage, which corresponds to the nymph of all known insect orders in which there is incomplete metamorphosis, beginning with the Paleodyctioptera. The successful development of the corpora allata, which further extended the action of JH, was undoubtedly assisted by their great importance in natural selection, i.e., the usefulness to the given species of the alterations that they caused. Paleontological data fully confirm the hypothesis that a relatively short time was needed before JH could affect the polypod stage (Holometabolous insects have been found in Permian deposits) and later the protopod stage, as occurs, for example, in certain of the contemporary parasitic Hymenoptera. In certain cases, in hypermetamorphosis for example, it can be assumed that the formation of JH or at least its operation is interrupted once or several times in the course of larval development.

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ON THE DISTRIBUTION OF AELIA BUGS (HEMIPTERA, PENTATOMIDAE) ON THE LEFT BANK OF THE VOLGA AND IN NORTHERN KAZAKHSTAN

T. G. GRIGOR'YEVA and E. S. TEREKHIN

Some species of Aelia have long been known to be serious pests of grain crops. Many Soviet and foreign authors (Sokolov, 1904; Engel'gard, 1927; Schulze, 1935; Vayssière, 1936; Tischler, 1938, 1939; Peredel'skiy, 1947, etc.) have referred to the great damage done by these insects and have cited cases of their extensive multiplication.

There is particular interest in this group of stink bugs at the present time in regions where virgin and fallow lands are being opened up, owing to the possibility that some of its representatives may turn their attention from wild grasses to sown wheat.

We conducted regular mowings and the collection of cereal bugs in the left-bank Volga areas of the Staro-Poltavskiy district (Stalingrad region) in 1951-53 and in the Karabalykskiy district (Kustanay region) in 1954-55 and 1958. (Tables 1 and 2).

Only single specimens of bugs of the genus Eurygaster were found in the collections from both locations. In the Kustanay region they were represented by a few specimens of E. manura L. and E. austriaca Schrank. E. integriceps Put. was also found in the Staro-Poltavskiy district.

Aelia bugs were more numerous in the collections. Two species (Aelia sibirica Reut. and A. acuminata L.) were always present both on the left-bank Volga and in Kazakhstan. Bey-Biyenko (1939) states that the former, which predominated is a regular component of the biocoenosis wheat fields in these districts. There were also small numbers of A. furcula Fieb. on the left-bank Volga and A. klugi Hahn in Kazakhstan.

Regular collections were made in the Karabalykskiy district, which lies in the north of the Kustanay region on the edge of the forest-steppe. The southern limit of the distribution of A. klugi clearly passes through this region, since we did not discover the species farther south (in the Akmolinsk region, for example). Kirichenko (1910, 1932) classifies A. klugi as a typical forest zone species that does not extend to the south of the forest-steppe. Like A. acuminata, which Kirichenko (1932) reports as being found on wild grasses mainly in deciduous forests, among shrubs and in the flood plains of water courses, A. klugi clearly makes greater demands on moisture than A. sibirica and A. furcula. The relativity high drought-resistance of these latter species is shown in their distribution in the arid steppes.

Table 1 shows the species breakdown of Aelia in both locations during the years of the study, and Table 2 the over-all numbers of Aelia in the same years on sown wheat and cereal grasses.

A comparison of these data with the graphic representation of wheather conditions in the districts given in Figures 1 and 2 enables one to draw conclusions as to the relationship between Aelia species and climatic and weather factors.

Weather conditions in June, the period in which the breeding of the bugs and the hatching of larvae is at its highest, are clearly of basic significance to the population dynamics of Aelia. There is a marked reduction in the numbers of all species when the weather is relatively more dry in June.

A. sibirica Reut. is more resistant to arid conditions. There is marked variation from year to year in the percentage ratio of the different species in the Aelia population (Table 1). A. sibirica Reut. predominates when June is hot and dry, but gives ground to A. acuminata L. when June is damper (A. klugi Hahn also appears in the collections in this case). The species breakdown for Aelia in 1958 contradicts these relationships to some extent. Weather conditions were similar to 1954, but there was a great difference in the economic situation. There was extensive plowing of virgin and fallow lands between 1954 and 1958, and the great increase in the areas under wheat fundamentally affected trophic relations in Aelia populations.

Table 1

Composition by species of Aelia populations on the left bank of the Volga and in the Kustanay region (as a % of the total number of bugs collected in the season

	Aelia sibirica Reut.	*Aelia acuminata* L.	*Aelia furcula* Fieb.	*Aelia klugi* Hahn.
Left-bank Volga				
1951	85.8	—	14.2	—
1952	64.6	35.4	—	—
1953	32.2	64.6	3.2	—
Northern Kazakhstan				
1954	37.7	61.5	—	0.8
1955	96.7	3.3	—	—
1958	87.7	10.3	—	2.0

It was reported by Kirichenko as early as 1932, and has been confirmed by other authors, that A. acuminata L. tends to live and develop on wild cereal grasses. There is more active adaptation to feeding on sown wheat in A. sibirica Reut. The increased population of Aelia on sown wheat in the Karabalykskiy district in 1958, by comparison with 1954, was mainly due to A. sibirica Reut. (Table 2).

There was a marked shift in the ratio of areas occupied by wild grasses to areas under sown wheat in favor of the latter between 1954 and 1958 in the virgin development areas. The species that actively adapted itself to life on wheat was evidently at an advantage. This is reflected in a considerable increase in the numbers of Aelia on sown wheat in recent years. It is, in fact, clear from Table 3 that:

a) wheat fields are populated almost exclusively by the species A. sibirica Reut.;

b) the incidence of A. sibirica Reut. in the over-all population balance of Aelia is continually increasing both on wheat and on wild grasses;

c) A. acuminata L. is being gradually displaced by the Siberian bug and is being transformed from the dominant species to a numerically small associated species.

It can also be assumed that the increase in the numbers

Table 2

Numerical totals of Aelia populations on the left bank of the Volga and in the Kustanay region

	Number of bugs per 500 double sweeps	
	in wheat	in cereal grasses
Left-bank Volga		
1951	7.5	1.5
1952	3.0	1.5
1953	—	5.5
Northern Kazakhstan		
1954	15.0	35.5
1955	6.0	7.5
1958	32.0	31.0

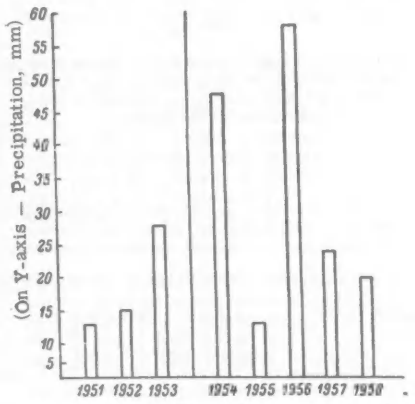

Fig. 1. - A - Left-bank Volga; B - Kustanay region.

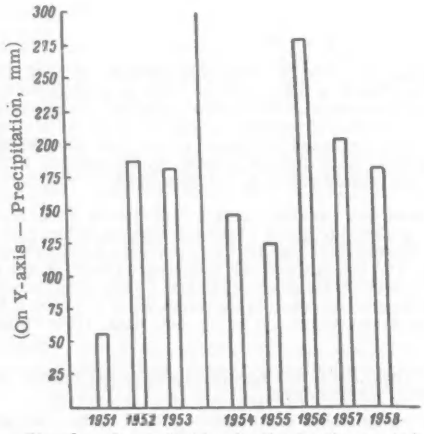

Fig. 2. - Precipitation in the growing period (April through September) A - Left-bank Volga; B - Kustanay region.

of Aelia in the area studied is due in part to inadequate activity on the part of parasites, especially parasites of eggs. Only once, in 1958, did we here discover a batch of Aelia

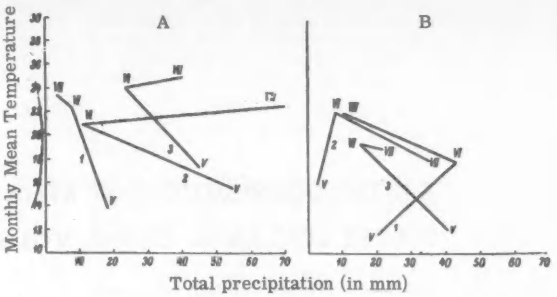

Fig. 3. - Temperature and precipitation graphs for May, June and July in the Left-bank Volga and the Kustanay region. A - Left-bank Volga; 1 - 1951, 2 - 1952, 3 - 1953; B - Kustanay region: 1 - 1954, 2 - 1955, 3 - 1958. Roman figures - months.

Table 3

Composition by species of Aelia on sown wheat and cereal grasses in the Karabalykskiy district (as % of the total number of A. sibirica Reut. on sown wheat in 1954)

	Wheat		Cereal grasses		
	Aelia sibirica Reut.	*Aelia acuminata* L.	*Aelia sibirica* Reut.	*Aelia acuminata* L.	*Aelia kiuprii* Hahn.
1954 . . .	100.0	—	41.9	206.4	3.2
1955 . . .	74.1	—	12.9	3.2	—
1958 . . .	258.0	12.9	300.0	54.8	16.1

eggs that had been infected by parasites. At the same time Rubtsov (1947), Tulashvili (1956), Polivanova (1957) and other authors all consider that the activity of parasites is the main factor that controls the numbers of Aelia. Rubtsov's remarks are interesting: he assumes that parasites have a beneficial effect in the control of Aelia in districts where the bugs are found in conjunction with Eurygaster integriceps. The latter provides a reservoir for the multiplication of the egg parasites. In districts in which Eurygaster integriceps is not found, the relationship beteen Aelia and the parasites is changed, and the former can become serious pests. This is even more likely in newly opened virgin lands which have vast areas of new wheat.

The number of Aelia specimens on wheat in the Kustanay region has already reached 1-1/2-3 per 1 m², and the average of 8-10% of damaged grains is beginning to affect the culinary properties of the flour. This shows that research establishments and economic bodies must pay the greatest attention to Aelia in this area.

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A CONTRIBUTION TO THE MORPHOLOGY AND BIOLOGY OF THE NETTLE TREE APHID SHIVAPHIS CELTICOLA NEVSKY (HOMOPTERA, APHIDOIDEA) IN TADZHIKISTAN

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Mordvilko pointed out as long ago as 1929 that there was need to study nettle tree (Celtis sp. div.) aphids in Transcaucasia and Central Asia, since an aphid from this plant had been described from the Pundjab (north-west India) under the name of Shivaphis celti Das (Das, 1918). A new species of nettle tree aphid described shortly after this by Nevskiy (1929) from Kazakhstan and named Therioaphis celticola Nevsky, has recently also been referred to the genus Shivaphis Das (Börner, 1952).

The biology of this species was practically unknown until quite recently. The fundartrices, sexuales and oviparous females and males had not been described. Apart from its theoretical interest to zoogeography, study of nettle tree aphids is also of practical importance. The great rise in the numbers of the nettle tree aphid that occurs in some years in Tadzhikistan results in considerable damage to plantations of the Caucasian nettle tree (Celtis caucasica Willd.).

The information given below on Sh. celticola Nevs. is based on the author's own observations from 1947 onwards in the vicinity of Stalinabad and in the Kondar ravine on the southern slope of the Hissarsk range. I have studied the whole life cycle of the species under the conditions at Stalinabad. I thinkthat it is advisable to describe the fundatrices, males and normal females. I wish to express my gratitude to my colleagues in the Tadzhik Academy's Institute of Zoology and Parasitology, M. Atayeva, S. Said-Aliyev and V. Bugayeva and to the laboratory assistant L. Treskinskaya, all of whom helped to assemble the materials.

Fundatrix, Ist instar (Fig. 1, a), green with bluish down, oval. The frons projects forward between the scapes with two clearly marked rounded protuberances. The antennae have 4 segments, the 3rd segment being the longest. Cormicles in the form of pores with thickened margins. Cauda not well developed; anal plate rudimentary and entire. Setae very sparse, with tapered ends.

A single very short marginal seta is found on the side of each abdominal segment. There are no hairs above. The primary sensorium of the last segment of the antennae has cilia but no accessory sensoria. There are 4 hairs on the end of the unguis. The eye has a small number of facets and an insignificant amount of red pigment. The three-faceted ocular tubercle is not developed.

Body	Antenna	III	IV	Hind tibia
0.48 x 0.22 mm	0.33 mm	0.16 mm	0.07 + 0.03 mm	0.20 mm
0.56 x 0.22	0.30	0.10	0.08 + 0.03	0.18
0.58 x 0.24	0.34	0.16	0.08 + 0.04	0.20
0.64 x 0.26	0.34	0.16	0.08 + 0.03	0.20
0.68 x 0.30	0.32	0.14	0.07 + 0.03	0.18
0.78 x 0.30	0.31	0.14	0.07 + 0.03	0.16

Ratio of length of body to antennae 1:2 (0.62:0.32).

Fundatrix, 2nd instar (Fig. 1, b). Yellowish-green with bluish waxy down. Joints of antennae black. Frons protuberant. The antennae have 5 segments. Cornicles stubb, widened a little at the base. Canda not will developed; anal plate semicircular, entire. Thoracic segments more or less separate. Lateral sensoria of the last segment of the antenna poorly developed. Three-faceted ocular tubercle still not developed although its pigment is already isolated.

Body	Antenna	III	IV	V	Hind tibia
1.10 x 0.50	0.54	0.18	0.10	0.10 + 0.04	0.32
1.00 x 0.44	0.54	0.18	0.11	0.10 + 0.04	0.32

Ratio of length of body to antennae 1:2 (1.10:0.54).

Fundatrix, 3rd instar – pronymph (Fig. 1, c). Whitish-green, with black joints in antennae. Tarsi dark brown. Thoracic segments strongly protuberant but still without wing pads. Ocular tubercle distinct, three-faceted. Cauda rudimentary, anal plate entire. The antennae have 6 segments, the 5th being the longest. The accessory sensoria on the 6th segment are more or less distinct.

Body	Antenna	III	IV	V	VI	Hind tibia
1.28 x 0.54	0.80	0.22	0.14	0.16	0.12 + 0.06	0.52
1.28 x 0.54	0.92	0.25	0.15	0.18	0.16 + 0.05	0.56

Ratio of length of body to antennae 1:1.5 (1.28:0.86).

Fundatrix, 4th instar – nymph. Whitish-yellow with black joints on antennae. The 6th segment is dark. Tarsi dark brown. Body covered with profuse dark blue down. Wing pads well defined. Pads of fore wings attain a length of 0.5 mm. Upper parts of hind femora dark as in adults. Antennae almost as long as in winged forms. Only traces of accessory sensoria now visible on 3rd segment. Cauda a cone-shaled evagination, anal plate entire. Eyes protuberant, of normal size.

Body	Antenna	III	IV	V	VI	Hind tibia
1.66 x 0.72	1.22	0.40	0.20	0.22	0.19 + 0.06	0.80

Ratio of length of body to antennae 1:1.36 (1.66:1.22).

Fundatrix. Winged, light green with dark blue waxy down. Head and protorax brownish, parts of mesothorax dark brown. Eyes reddish-brown, almost black. Antennae brownish: 1st and 2nd segments light brown, 3rd segment yellowish with a dark center containing accessory sensoria and with a black apex. The 4th segment smoky-gray and darker towards the end. 5th and 6th segments entirely dark brown. No signs of darkening of rostrum. Legs transparent yellow. Femora tinged with brown, extremities of tibiae darkish. Tarsi dark brown. Only the extremities of the hind femora have a darker ring. Wings with normal venation but veins of the fore wings are edged with brown. Abdomen light green, without spots and stripes. Cauda the color of the body.

The aphids are of average dimensions – 2.08-2.10 mm, wing 2.40-2.50 mm. The body is elongated and almost without setae, except for short spine-like setae on the tibiae.

The frons is flat with two rounded protuberances, each of which carries one short (0.02 mm) pointed seta. The eyes are protuberant and there is a clearly defined three-faceted ocular tubercle. Antennae shorter than body and almost without setae. Two or three setae, the longest of which is 0.5 the diameter of the segment, found on the 3rd segment. The unguis is 1/4 (0.06 mm) of the base (0.24 mm) of the 6th segment. Four short setae with one apicalone at the end of the unguis. Primary sensoria on 5th and 6th segments circular with a corona of cilia. Sensorium of 6th segment has indistinct accessory sensoria (4-5). On the 3rd segment there are 9-13 transverse oval accessory sensoria a short distance from each other in a single line,

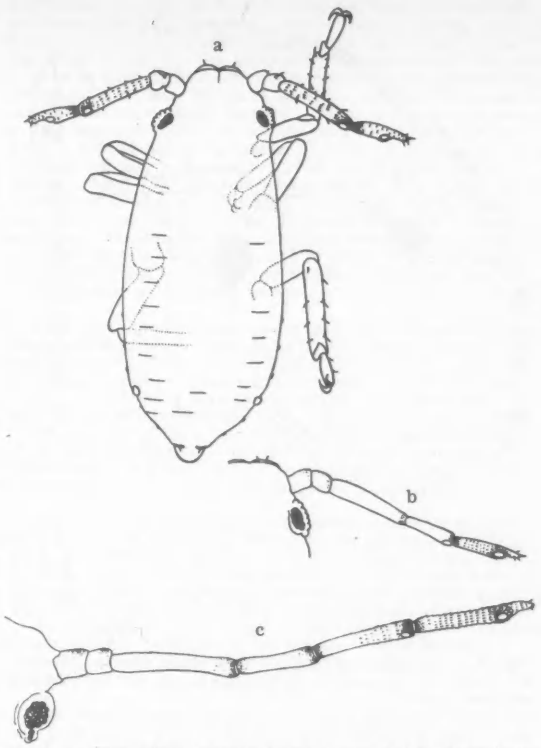

Fig. 1. - Shivaphis celticola Nevs., larva of fundatrix (orig.) a - general appearance of 1st instar; b - head and antenna of 2nd instar; c - antenna of 3rd instar.

further from the base of the segment but not reaching its end.

The rostrum is short and does not reach the bases of the mid coxae. The cornicles are stubby but not broadened at the base and their length is less than their breadth. The anal plate consists of two plates with a distinct wide slit down the middle and short needle-shaped setae. The cauda is bulbous. The legs are ordinary, there are 5 setae on the first segment of the tarsus, 2 above and 3 on the sides.

Body	Width of head with eyes	Distance betwn. inner edges of eyes	Antenna	I	II	III	IV	V	VI	Cornicles	Cauda	Hind tibia
2.08	0.50	0.32	1.77	0.08	0.08	0.64	0.34	0.33	0.30 (0.24±0.06)	0.04	0.12	1.20

Summer parthenogenic females (Fig. 2). Winged, greenish-yellow with dark blue waxy down. Abdomen a single shade of green. Body elongated. Antannae equal to or slightly longer than body, sometimes slightly shorter. Setae scarcely discernible on body. Acesssory sensoria 13-19, circular to oval, on one line and across the width of the 3rd segment. Rostrum does not reach the base of the mid coxae. Otherwise as fundatrix.

Body	Antenna	III	IV	V	VI	Cornicles	Rostrum
2.18x0.78	2.20	0.72	0.42	0.48	0.32+0.10	0.03	0.40
1.74x0.48	1.97	0.60	0.38	0.42	0.31+0.10	0.03	0.32

Ratio of body length to antennae 1:1 or 1:0.88 (2.18:2.22 or 1.74:1.97).

Winged female sexuales scarcely distinguishable from summer winged sexuparae. 9-12 sensoria on 3rd antenal segment.

Body	Antenna	III	IV	V	VI	Tubles	Stylet
1.86	1.82	0.60	0.36	0.36	0.26 + 0.08	0.03	0.34

Male (Fig. 3). Winged, yellowish-green and covered with dark blue waxy down. Head and prothorax light brown, meso- and metathorax dark brown. Gonapophyses black. Joints of 3-4 and 5-6 segments of antennae wholely brown. Head wide, eyes greatly protuberant and black. Width of head and eyes 0.49 mm, distance between inner edges of eyes 0.30 mm, distance between frontal extremity of frons and occiput 0.20 mm. Antennae longer than body with accessory sensoria on 3rd segment (19-24), 4th segment (4-8), 5th (5-9) and 6th (3-6). Sensoria circular to oval on 3rd and 4th segments and circular on 5th and 6th segments. Smoky gray edgings to wing veins less marked than in winged sexuparae, cauda bulbous, anal plate bilobed but with a wider slit than in ordinary winged forms.

Body	Antenna	III	IV	V	VI
1.66 x 0.52	1.81	0.61	0.31	0.37	0.36 (0.28 + 0.08)
1.50 x 0.44	1.82	0.62	0.32	0.38	0.36 (0.28 + 0.08)

Oviparous female (Fig. 4). Wingless, yellowish-green with dark blue waxy down. Eyes black. Antennae with black joints. Apices of hind femora slightly smoky gray. Body almost without setae.

Frons with 4 protuberances. Antennae shorter than body, without accessory sensoria on 3rd segment. Lateral sensoria on 6th segment scarcely discernible. 4 hairs (one opical) at end of unguis. Hind tibia slightly broadened in the basal half and carrying 30-40 pseudosensory setae. The latter are difficult to see, owing to transparency of the parts. Cauda a flattened cone, anal plate scapulate and entire, with many needle-like setae.

Body	Antenna	III	IV	V	VI	Hindtibia
1.94x0.82	1.62	0.56	0.30	0.32	0.30(0.22+0.08)	1.06x0.06

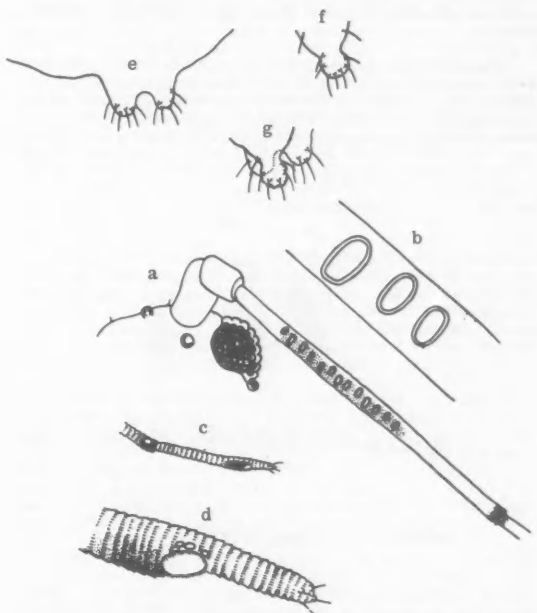

Fig. 2. - Shivaphis celticola Nevs., summer winged parthenogentic female. (Orig.). a - head and 3rd segment of antenna with accessory sensoria; b - accessory sensoria at high magnification; c - 6th segment of antenna at low magnification; d - the same at high magnification; e - anal plate; f - cauda; g - cauda and anal plate.

Ecology. In Tadzhikistan the species lives on the Caucasian nettle tree (Celtis caucasica Willd.). The aphids have also been recorded on this plant in Kazakhstan – in the Chimgan mountains and the Karzhan-Tau (Nevskiy, 1929, 1951). Aphid colonies are found as isolated individuals on the underside of the leaves. All the generations consist of winged parthenogenetic viviparous females. The males are also winged and the oviparous females are apterous.

In the conditions at Stalinabad (Botanical Garden, 840 m above sea level) the nymphs of the fundatrices emerge in late March or early April from the eggs. The earliest emergence of the nymphs was recorded in 1947 and 1958. In 1947, for example, the nymphs of Sh. celticola fundatrices emerged on 30-31 March, when the mean diurnal temperature was 11.9° and the maximum 21.0°, by 31 March the mean diurnal temperature had risen to 15.2°. In 1958 the nymphs emerged from the eggs on 29-30 March, when the mean diurnal temperature was 10.1-14.6° and the maximum 19.6-21.4°.

In the remaining years the nymphs emerged in the first half of April. (e. g. on 5-6 April in 1952 and 6-7 April in 1959). In 1959 the mean diurnal temperature on 7 April was 19.6° and the maximum 24.3°. The weather was clear and dry and relative air humidity was 48%. The slight fall in temperature after 7 April retarded the development of the nymphs that had hatched and held back further hatchings from the eggs.

The latest dates for the emergency of Sh. celticola nymphs of fundatrices were observed in 1948, 1950 and 1957. Thus, in 1957 1st and 2nd instar nymphs made up the majority of the aphid colonies on 18 April; only a few nymphs had attained the 3rd instar by this date. Consequently mass hatching of the nymphs of the fundatrices could not have occurred before 12-13 April in 1957, when the mean diurnal temperature had reached 15-16° and the maximum 21-22°.

The nymphs of Sh. celticola fundatrices emerge correspondingly later in the mountains than at Stalinabad, in relation to absolute altitude. When, for example, the nymphs emerged on 3-4 April in 1955 at Stalinabad, they emerged on 9-10 April, i. e. 5-6 days later, in the Kondar ravine (southern slopes of the Hissarsk range, 1100 m above sea level). Upon inspection on 14 April 1955 only nymphs of the 2nd and 3rd instars were found on the unfolded leaf buds of the nettle tree. On nettle trees that grow at higher altitudes (e. g. 1400-1500 m) the nymphs of Sh. celticola fundatrices may emerge correspondingly later, not before the 21st of April, or the end of the month in years when the spring is late.

Thus, the nettle tree aphid is one of the last of the dendrophylic species of aphid in Tadzhikistan to hatch. When the nymphs of Sh. celticola fundatrices are hatching at Stalinabad, adult fundatrices of other species of aphids can already be found: Metopolophium dirhodum Walker on the rose, Nevskya

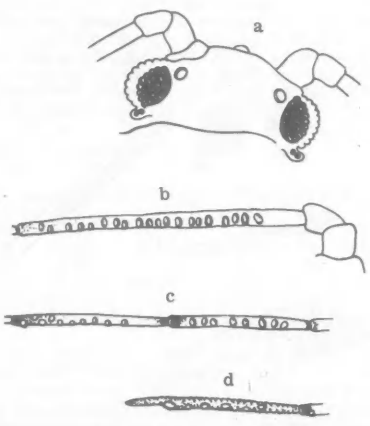

Fig. 3. - Shivaphis celticola Nevs., male. (Orig.) a - head; b - 3rd segment; c - 4th and 5th segments of antenna with accessory sensoria; d - 6th segment.

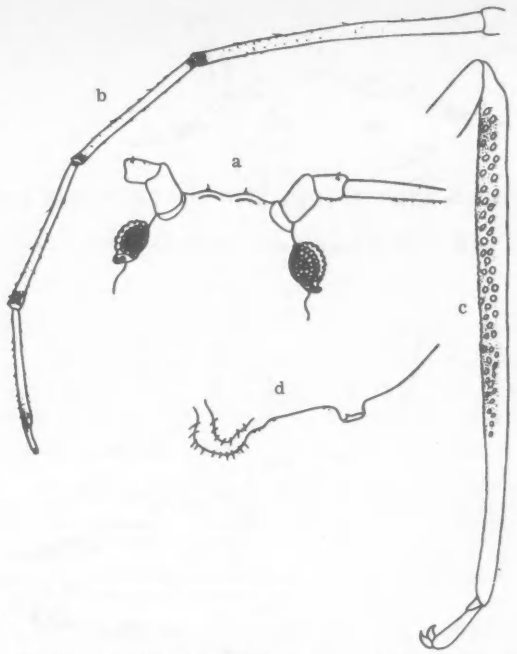

Fig. 4. - Shivaphis celticola Nevs., normal female. (Orig.). a - head; b - antenna; c - hind tibia; d - cornicle cauda and anal plate.

mahaleb Koch on the manhaleb cherry, Rhopalomyzus lonicerae Siebold and Hyadaphis xylostei Schrk on woodbine, while in years when the spring is early (1958) hatching of the nymphs of Sh. celticola fundatrices coincides with the appearance of adult apterous parthenogenetic females or winged migrantes of the second generation of Metopolophium dirhodum Walker, Brachycaudus cardui L., Hyadaphis xylostei Schrk., Nevskya mahaleb Koch and others.

With respect to the hatching of the nymphs of the fundatrices Sh. celticola is more similar to Callipterus juglandis Frisch., the nymphs of which emerge from the eggs at the end of March (in years with an early spring) or more frequently in the first half of April. Thus, in 1953, the first nymphs of C. juglandis fundatrices hatched at Stalinabad on Persian walnut on 10-11 April.

The fact that the nymphs of the fundatrices of these species develop earlier would seem at first glance to be most probably due to the fact that their host plants begin to vegetate very early. Thus the cherry plum (Prunus divaricata) and the mahaleb cherry (Cerasus mahaleb) come into flower and begin to open their leaf buds in the first ten days of March. Adult fundatrices and the nymphs of second generation parthenogenetic apterous females of the aphids that live on these plants (Brachycaudus cardui L. and Nevskya mahaleb Koch) have already appeared by this time. The apterous females are noted between 7 and 15 March. Development of the fundatrices is, however, observed considerably later in Neanuraphis catharticae, which belongs to the same subfamily of the Aphidinae but lives on the buckthorn. In 1959, for example, the first nymphs of the fundatrices of this species emerged from the eggs at Stalinabad on 25-26 March and they continued to hatch right down to 31 March. It can be stated with certainty that early or late development of the nymphs of fundatrices in the majority of dendrophylous aphids is largely dependent on the early or late appearance of vegetation in their food plants. Late development of the nymphs of Sh. celticola fundatrices is therefore associated with the late appearance of vegetation in their food plant.

V. I. Zapryagayeva[1] has found that the leaf buds of the

[1] Here and later the data on the biology and distribution of nettle trees are taken from the monograph of V. I. Zapryagayeva on the wild fruit trees of Tadzhikistan, which is being prepared for printing.

neetle tree swell in the first few days of April and that they are fully opened by 10 April. The fundatrices of Sh. celticola begin to emerge from the eggs when the buds of the nettle tree begin to swell. The appearance of vegetation in the nettle tree is also liable to fluctuate in relation to seasonal temperature conditions, height of locality, exposure of mountain slopes and other natural factors. Thus, in the Kandar ravine at an altitude of 1000-1100 m, the nettle tree flowered earliest in 1954 (3 April) and latest in 1954 (18 April). At altitudes of 800-900 m the nettle tree flowered at the end of March, and at 2000 m at the end of April. The leaves of the nettle tree develop at the time of flowering. By the time, therefore, that the first young leaves of the nettle tree have appeared, the nymphs of Sh. celticola fundatrices have already emerged from the eggs and some of them, that have passed through the first moult and reached the 2nd instar, are already feeding on the young leaves.

We found in almost all cases that mean diurnal temperature conditions when the nymphs of Sh. celticola fundatrices emerged were 14-16° with a maximum of 21-22°. It must be assumed that only temperature conditions within these limits are able to ensure the development of the embryo inside the overwintered eggs of Sh. celticola and the swelling of the nettle tree buds, thus synchronizing the development of the two components – the food plant and its obligatory inhabitant. This synchronous development ensures that the nymphs of the fundatrices can feed on hatching.

In the conditions at Stalinabad adult fundatrices appear in late April or early May, according to the type of spring. Thus, in 1955 when the first nymphs emerged on 3-4 April, the first adult fundatrices appeared on 21-22 April, when the mean diurnal temperatures were 15-16° and the maxima 21-24°. In 1955 17-18 days were required for development to the adult stage. The length of this period can be explained by a slight fall in temperature between 11 and 20 April – mean temperature was 16.5° in the first ten days of April and only 7.3° in the second ten days.

In 1959 the adult fundatrices of Sh. celticola appeared on 19-20 April, i. e. 12-13 days after the nymphs emerged from the eggs, the mean diurnal temperature being 22° and the maxima 28-30°. In this case there was a gradual rise in temperature from 6 to 20 April, the period in which the nymphs developed to the imago, the mean temperature being 13.4° for the first ten days, increasing to 19.3° in the second ten days.

The adult fundatrices of Sh. celticola very late at Stalinabad in 1948, 1950 and 1957. Thus in 1957 the first adult fundatrices were found on 7 May, 23-24 days after the nymphs emerged from the eggs, the mean diurnal temperature being 18° and the maximum 25.4°. The considerable time needed for the development is also due in this case to the fact that the rise in temperature between 13-14 April and the beginning of May was very slight (a mean temperature of 9.58° in the first ten days of April, 14.7° in the second ten days, 13.5° in the third and only 17.3° in the first ten days of May.

Adult fundatrices of Sh. celticola normally appear 5-6 days later in the Kondar ravine than at Stalinabad. In 1955 the first winged fundatrices were observed at Kondar at the very end of April and at Stalinabad on 21-22 April.

On the whole, the period in which adult fundatrices of Sh. celticola appear begins before the leaves of the nettle tree are fully formed.

The aphids continue to develop on the nettle tree throughout the year, although there is a sharp decline in their numbers in July and August. A slight increase at the beginning of September is quite noticeable by the end of the month. By the end of September Sh. celticola has given rise to not less than 15-16 generations of viviparous parthenogenetic females.

It should be noted that Sh. celticola multiples so rapidly in nettle tree plantations in the Stalinabad Botanical Garden that the undersides of most leaves are densely covered with vast colonies of the species. Such intensive multiplication of Sh. celticola is hardly ever found in the mountains where the nettle tree grows wild, although there is 600-700 and sometimes even 800 mm of precipitation annually as against only 500-600 mm in Stalinabad. Despite the considerable amount of precipitation on the southern slopes of the Hissarsk range, in the Kondar ravine for example, the soil is not greatly wetted, the rain does not soak into the ground and evaporates rapidly owing to the sparseness of the vegetation.

Savzdarg (1955) noted a similar phenomenon in Dysaphis devecta Walk., which multiplied intensively in shady parts of an apple orchard. Shaposhnikov (1956) cites similar observations for other species of aphids.

It is quite correct to assert that the development of aphids is greatly affected by the environment of their food plants, because of changes in the physiological state of the hosts (Shaposhnikov, 1959). This is treated as being the result of the prolonged existence of aphids on a given food plant and their adaptation to feeding on it.

The first sexuales and males of Sh. celticola appear at the beginning of October. In 1956 males and adult oviparous (normal) females appeared in large numbers at Stalinabad on 17 October. There were 2-3, and more rarely 4, mature eggs in the ovaries of almost all the females discovered on that day. Winged sexuales continued to be encountered at the same time as the bisexual specimens and were found right up to 22 October in 1957. The oviparous females live considerably longer than the males. In 1956 there were considerably fewer males in the collections beginning with 9 November and by 22 November only normal females with almost empty ovaries were encountered. It was difficult by this time to find a female with 1-2 eggs in the ovaries.

Sexuales, males and oviparous females of Sh. celticola are found a little earlier in the Kondar ravine. In 1956 the first males were observed on 3 October and scarcely any were still to be found by 29 October. Only oviparous females that were already at the end of their life were found in collections of 17 November.

At Stalinabad the first egg laying was noted on 20 October (1956 observations) and the last freshly laid eggs on 22-23 November. Egg laying was most intense at Kondar between 10 and 22 October. The eggs are laid in the bud axils and directly on the surface of shoots. Many of the eggs laid on the surface of shoots are, however, washed off before the spring by rain or simply perish.

The egg laying of Sh. celticola is finished by the time the nettle tree sheds its leaves, which begins at the end of October.

Distribution. Within Tadzhikistan Sh. celticola is found in the Stalinabad Botanical Garden on nettle tree plantations (secondary colonization), in the Kondar ravine on the southern slope of the Hissarsk range, on the southern slope of the Darvaz range in the Kalai-Khumba district on the river Khumbou, on the south-western spurs of the same range, in the vicinity of Muminabad along the river Yakh-Su (S. A. Said-Aliyev), on the southern slope of the Khazrati-Sho range near Dashtidzhum and the village (kishlyak) of Nishorak (L. V. Treskinskaya and S. A. Said-Aliyev, 1957), on the road to Kulyab in the southern spurs of the Karateginskiy range near Nurek (Treshinskaya), and the Khodzha-Mumin mountains to the north of the Moscow district. On the whole the distribution of Sh. celticola in Tadzhikistan is confined to altitudes between 800-900 and 1500-1600 m above sea level, except at Stalinabad where the species is of secondary introduction.

In southern Kazakhstan Sh. celticola has been reported from the Karzhan-Tau at altitudes of 1200-1500 m and from the Chimgan mountains (Nevskiy, 1929, 1951). Despite the presence of the nettle tree (Celtis caucasica) in the Transcaucasian republics, this species is not encountered (Rusanov, 1942; Dzhibladze, 1956, 1958); nor is it in the Crimea or in eastern Ciscaucasia (Bozhko, 1957a, 1957b).

Thus the distribution of Sh. celticola in the USSR only embraces Central Asia and southern Kazakhstan approximately in the area of latitude 38-43°N, and the species is always found on the southern slopes of mountains in stony dry gullies, on detritus and cliffs, i. e. almost all the localities in which the nettle tree grows. Sh. celticola has not, as yet, been discovered at altitudes of 1800-2000 m in Tadzhikistan, where the nettle tree still grows.

The nettle tree is found in Central Asia and Kazakhstan in the Kopet Dag, the Karatau and Chu-Ili mountains, and on the southwesterly spurs of the Dzhungar Alatau, but the occurrence of Sh. celticola in these localities is not known.

In the Pamir-Alai region the nettle tree is also found in the western part of the Gorno-Balkhash autonomous region: Sh. celticola is only known here from Kalan-Khumba. It has not been collected in northern Tadzhikistan either, where the nettle tree is found in the Kuramin range, the Mogol-Tau

and the Turkestan and Zeravshan ranges. Although the nettle tree is found at heights of up to 1800-2000 m absolute altitude, the conditions most favorable to it are between 1100 and 1400 m, which coincides with the universal distribution of Sh. celticola Nevs.

The distribution range of the Caucasian nettle tree in the USSR is considerably wider and includes the Caucasus at heights of up to 600 m abs. alt. The distribution of Sh. celticola in the USSR is thus considerably more restricted than that of its food plant. To the south of the USSR this nettle tree is also found in northern Afghanistan and in Iran (Lozina-Lozinskaya, 1951), but we have no data on the distribution of Sh. celticola in these areas.

General remarks. There are two additional species of the genus Shivaphis Das: one – Sh. celti Das (= celticolens Takahashi, 1923) lives on Celtis australis is north-western India (the Pundjab) and in Ceylon (Das, 1918; Shaposhnikov, 1955), on Celtis sp., C. nervosa and C. sinensis in Japan and China (including Formosa), and on Celtis sp. on Loochoo and in the Philippines (Takahashi, 1921, 1923, 1924a, 1930, 1931; Chu, 1957); the other species – Sh. celticolens Essig and Kuw. lives on Celtis sp. on Formosa (Takahashi, 1924a). Sh. celticola therefore occupies the most westerly and north-westerly part of the area of Shivaphis Das.

It is interesting to trace the distribution of nettle trees in past geological epochs. The genus Celtis L., together with Ulmus and Zelkova from the Ulmaceae, has been found in the Oligocene flora of Europe and in Eocene deposits from higher latitudes. A great diversity of species has been noted as early as the Miocene and also in lower Pliocene remains of flora in the vicinity of Lake Issyk-Kul and in Sinkiang. Here remains of Populus, Salix, Ulmus, Acer, Lonicera, Spiraea and Fraxinus have been found in addition to Celtis as components of a temperate flora of the Turgai type. Species of the genus Celtis have also been discovered in the Sarmatian deposits of the Black Sea region (Krynki) and in conjunction with Ulmus, Zelkova, Juglans, Alnus, Betula and other broad-leaved types in the Tertiary flora of the northern provinces of China. Species of the genus Celtis are also known from the Eocene deposits of Colorado and the upper Miocene deposits of the Rockies (lake Florissant) in North America (Krishtofovich, 1946, 1957).

Consequently the past distribution of the genus Celtis L., at least until the middle of the Tertiary period, embraced the more northerly latitudes of Asia and America and was a component of the Turgai type of temperate broad-leaved flora. In subsequent geological periods the area of the genus Celtis gradually contracted and occupied more southerly latitudes. This is shown, for example, by the fact that C. australis coexisted with Zelkova ungeri, Acer semenowii and various species of Ulmus (Kutuzkina, 1954, 1975) in the Pliocene in the vicinity of Lake Issyk-Kul and in sandy-clay deposits of Pliocene age in the neighborhood of Lenger, along the Ugam and in the Ugam range in the south-western Tien Shan (the south of the Kazkh SSR), and near the Pskemskiy and Chatkal'skiy ranges in Kirgizia; the nettle tree is no longer present in the contemporary flora of Chakhara on the borders of Eastern Mongolia, most probably because of increased aridity in the climate, which has been particularly marked since the upper Pliocene (Il'in, 1958).

On this basis we can assert that both Sh. celticola and its food plant were more widely distributed in the past and that, on the whole, the contemporary distribution of Shivaphis species resembles that of a relict.

Comparative notes. The summer parthenogenetic females of the aphids from Tadzhikistan are scarcely distinguishable from the same forms of the species from Kazakhstan, apart from the fact that they have 13-19 accessory sensoria on the 3rd segment of the antennae as against 10-15 in the Kazakhstan aphids.

A comparison of Sh. celticola with Sh. celti from the Pundjab (north-western India) shows that these two species are morphologically akin, but that there are quite clearly defined differences: the Indian species, Sh. celti, is smaller, has shorter antennae, a long cauda and only 9-10 accessory sensoria on the 3rd antennal segment.

	Body	Antenna	III	IV	V	VI	Cauda
Sh. celticola.	1.78	1.98	0.66	0.41	0.40	0.30+0.08	0.072
Sh. celti Das.	1.45	1.50	0.55	0.25	0.24	0.24	0.12

If one can accept Takahashi's data, a comparison of Sh. celticola oviparous females with normal Sh. celti females from Formosa shows that the Chinese aphids have very short antennae (0.87 as against 1.62 mm). Sh. celti males from China are also smaller and have shorter antennae than Sh. celticola males. These data confirm that Sh. celticola Nevs. is an independent species.

SUMMARY

1. Shivaphis celticola Nevsky lives on the undersides of the leaves of the Caucasian nettle tree (Celtis caucasica Willd.) and is found with its food plant in Tadzhikistan exclusively in the mountains at altitudes of between 1000-1100 and 1500-1600 m above sea level, on dry southern slopes on detritus and rock faces. It is of secondary introduction at Stalinabad.

2. The nymphs of fundatrices hatch from the eggs in late March or early April, or as late as mid April in some years.

3. Adult fundatrices normally appear 12-13 days after the nymphs emerge from the eggs, but a marked fall in temperature may prolong this development to 17-24 days. Under these circumstances the adult fundatrices appear between 1 and 10 May.

4. Sh. celticola Nevsky gives rise to approximately 15-16 generations of viviparous parthenogenetic females. All generations are winged, except for the oviparous females, which are apterous. The bisexual generation of the species develops in the middle of October and lasts until the middle of November. The females live longer than the males.

5. The species is restricted to Central Asia and southern Kazakhstan, where it is known in the mountains of the western Tien Shan and the Hissaro-Darvas system, approximately between 28 and 43° North.

6. Judging by the wide and more northerly distribution of nettle trees up to the Pliocene, it can be assumed that the contemporary distribution of Sh. celticola and of Shivaphis species in general suggests that of a relict.

7. Sh. celticola Nevs. is morphologically skin to Sh. celti Das, which is found in northwestern India, the Philippines, Japan, the south-east of China and Formosa.

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NEW GALL MIDGES (DIPTERA, ITONIDIDAE) IN SOUTHEAST KAZAKHSTAN

P. I. MARIKOVSKIY

The present communication is a continuation of a projected series of articles by the author which will describe new gall midges in Kazakhstan. Specimens of the species described are to be found at the Institute of Zoology of the USSR Academy of Sciences in Leningrad.

Until recently ten species of gall midges belonging to seven genera have been known from galls on tamarisks, mainly from the Egyptian district of the United Arab Republic, Algeria, Tunis, Italy, Portugal, France, Iran and India. Examination of gall midges from tamarisk galls collected by the author and the entomologist I. D. Mityayev in the vicinity of the middle and lower reaches of the Ili River (Alma-Ata and Taldy-Kurgan regions) has led to the establishment of seven new species belonging to two genera. Of the seven species six belong to the genus Isosandalum (Kieffer, 1912) which had been thought to be monotypic. The new species are clearly distinct. Biological data on some of the species described are given in a paper by Mityayev (1961).

Isosandalum barbatum Marikovskij, sp. n. (Fig. 1).

Male. Length 2.0-2.3 mm. Antennae 2 +13 - 14. Pedicels of flagellar segments poorly developed, their length normally equal to or less than their diameter. The penultimate segments sometimes without pedicels, the first and second flagellar segments not fused. There is a circumfilum forming a wavy band around the basal part of each segment. The hairs are seated on tubercles and twice as long as the segment. The terminal segment is clavate and elongated; there are sometimes noticeable suggestions of division on two segments (2 and 14), each of which has two bands of circumfili and two groups of setae. Palpi one-segmented, small, pyriform on a slender base. Tarsal claws have one tooth with a broad base. Empodium short, broad, considerably shorter than the claws. Subcosta closely adjacent to costa, 3rd vein almost straight, terminating apically, 5th vein branched. The gonocoxite has a strongly convex external edge and concave inner edge, is slightly hairy and has an acute inwardly curving apex. Medially at the junction of the base of the gonocoxite and the ventral surface there is a large highly sclerotized prominence encompassing the gonofurca and fulfilling the role of the missing gonosternum. The gonostylus is half the length of the gonocoxite, almost straight, large and attached proximally to the apex of the gonocoxite. The dorsal plate is distinct and consists of two sclerotized and almost lunate flabella. The phallomeres, which are longer than the dorsal plate, are also hightly sclerotized, with a deep recess and long narrow flabella. The gonofurca is thick, slightly sclerotized and extended almost at a right angle to the apical dorsal surface.

Female. Length 2.2-2.6 mm. Antennae 2 + 10 - 12, short, scarcely more than 1 1/2 times the length of the head. The segments of the flagellum are small and cylindrical without setae, and equal in length to their diameter. Only the last segment, which shows traces of the fusion of several segments, is large. The last segment is also occasionally small, in which case the antennae are 2 +12. The circumfilum is not marked and cannot be traced when the specimen is prepared in the normal manner. The funicular segments are covered with many circular evaginations that form a honeycomb sculpture on the surface. This sculpture is more developed towards the end of the funicle and is most marked on the last segments. The ovipositor, which is blunt and without a sharp point, has a scarcely noticeable azygous prominence beneath two small terminal lobes and is fringed by a dense semicircle of curly setae.

The species is similar to Isosandalum provinciale Kieff. (1912) in the general appearance of the male genitalia, in which the gonostylus is situated typically subapically, and in the chaetotaxy of the ovipositor, but differs from it in the form of the dorsal plate and the parameres of the hypopygium and also in having teeth on the claws.[1]

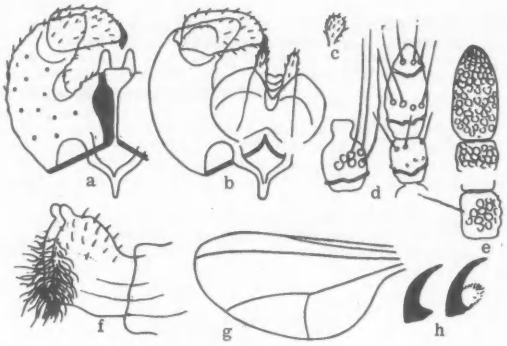

Fig. 1 - Isosandalum barbatum, sp.n. a - hypopygium from below; b - hypopygium from above; c - palpi of male; d - 5th and 12th-13th flagellar segments of male; e - 5th and 9th flagellar segments of female; f - ovipositor; g - wing of male; h - tarsal claws.

The description is based on 29 males and 50 females from Tamarix ramosissima galls. The galls (Fig. 13, a) are small and spindle-shaped, 5-8 mm long, with a single larval chamber, and grow on the fine twigs of this shrub.

Isosandalum mitjaevi Marikovskij, sp. n. (Fig. 2).

Male. Length 2.0 mm. Antennae 2 +12. Flagellar segments gradually decrease in size towards the apex and have almost globular nodules and setae slightly longer than the diameter of the nodules. The terminal segment is clavate and elongated. Circumfili indiscernible. Nodules of the funicular segments covered with many tubercles. Palpi one-segmented. Tarsal claw with one tooth. The empodium small and considerably shorter than the claws, pulvilli rudimentary. Subcosta closely adjacent to costa, 3rd vein slightly curved, terminating slightly subapically. Gonocoxite sparsely covered with hairs, less curved

[1] This example once again demonstrates the unsuitability of separating the tribe Dasyneurini from the tribe Oligotrophini by the presence of denticles on the claws.

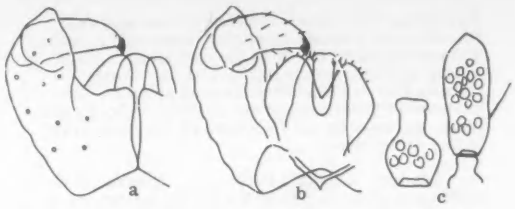

Fig. 2 - Isosandalum mitjaevi, sp.n. a - hypopygium from below; b - hypopygium from above; c - 5th and 12th flagellar segments of male.

than in I. barbatum and with the apex less steeply inclined to the middle. Medio-basal angle of gonocoxite with ventral surface extended in a rectangular flabellum covering the gonofurca. This flabellum, unlike that in I. barbatum, is not highly sclerotized and opaque in parts. The gonostylus, which is broad, half as long as the gonocoxite and apically tapering, is considerably more basad of the apex of the gonocoxite. Dorsal plate constricted at base, with a deep recess and rounded, highly sclerotized flabella; parameres with a deep rounded recess and long narrow flabella of the same length as the dorsal plate.

Close to I. barbatum, sp. n., but differing from it in having fewer antennal segments with noticeably lengthened setae, a less curved gonocoxite, anal plate and parameres of somewhat different form and a more distinctly curved in 3rd vein in the wing.

Described from one male. The larva lives on the green twigs of Tamarix ramosossima and does not cause gall formation. It may be a symbiont of Isosandalum dentipes, sp.n.

Isosandalum dentipes Marikovskij, sp. n. (Fig. 3).

Male. Length 3.2-3.6 mm. Antennae 2 +13. First and second flagellar segments fused; setae half the length of the nodules; last segment tapered, drop-shaped. Circumfili forming a band near the base of the nodule with a whorl of fine hairs beneath and another of coarse hairs above. Palpi one-segmented, constricted at the base and covered with fine cilia. Very fine subulate denticles on claws lightly covered by the pulvilli, the number of denticles varying from 1 to 4, usually one more denticle on the internal than on the external claw. Empodium and pulvilli shorter than claws. Abdomen thin and elongated. Gonocoxites broad and evenly covered with sparse setae and with prominences on the ventral surface that encircle the stylet. Gonostyli almost subapical, covered with fine short setae. The apical prominence on the gonocoxite, which is so distinct in I. barbatum, sp. n. and I. mitjaevi, sp. n., is scarcely discernible and can only be seen from the side. Dorsal plate broad and short. The tergite of the 8th abdominal segment forming a rounded sclerotized prominence at the base of the dorsal plate. Parameres higher and narrower than the dorsal plate, more highly sclerotized, with almost parallel sides, tapering at the base. Sclerotized short pitcher-shaped gonofurca with spatulate apex bent at right angles dorsally and with a slightly tapering base.

Female. Length 3.2-3.8 mm. Antennae 2 + 9-11, usually 2 +10. Number of flagellar segments dependent on the extent of fusion of the terminal segments. Cylindrical flagellar segments narrowed noticeably at the ends, last segment greatly lengthened and broadening apically (length 3-4 times its diameter). Circumfilum an undulating band near the center of the segment. Tarsal claws simple or with one subulate denticle. Ovipositor covered with fine short setae, almost cylindrical, slightly broadening towards the end and with the apex slightly tapered downwards and backwards, two small narrow flabella on the dorsal surface and two additional small flabella below them in a pocket-like depression.

Described from 22 males and 30 females. Well distinguished from the other species by the fine-toothed claws and the form of the dorsal plate and parameres.

The larvae of these gall midges live on the twigs of Tamarix ramosissima (Fig. 13, b). There are several generations in a year. In the summer the larvae live in the fine green terminal shoots of the plant, where they give rise to scarcely discernible swellings. The larvae of the next generation live in the woody twigs where they give rise to scarcely perceptible deformations. The chamber is closed around the larva. Some branches are so colonized by larvae that they become brittle in time and break off.

Isosandalum iliense Marikovskij, sp. n. (Fig. 4).

Male. Length 3.0-3.2 mm. Antennae 2 +14. Flagellar segments decreasing in dimensions gradually and perceptibly, setae well developed and as long as the slightly elongated globular nodules. The first flagellar segment covered with thick short setae, which form a proximal whorl on the subsequent segments. The terminal flagellar segment usually long rather than short. The circumfili forming a single large cell with a connecting cross-thread. Palpi one-segmented, globular, covered by fine cilia and with a single large seta. Wings

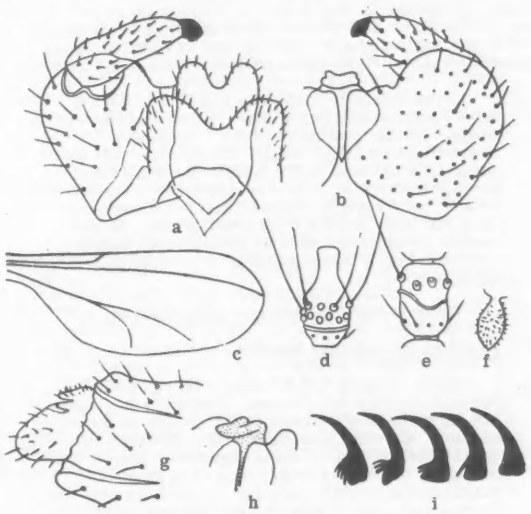

Fig. 3 - Isosandalum dentipes, sp.n. a - hypopygium from above; b - hypopygium from below; c - wing of male; d - 5th flagellar segment of male; e - the same in the female; f - palp of female; g - ovipositor; h - gonofurca; i - claws.

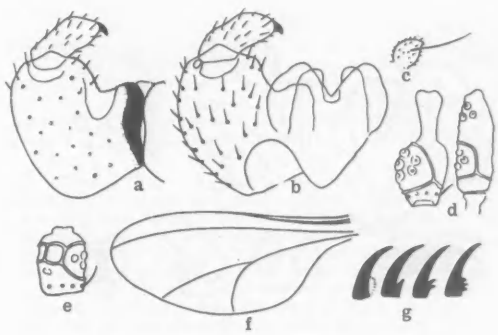

Fig. 4 - Isosandalum iliense, sp.n. a - hypopygium from below; b - hypopygium from above; c - palp of male; d - 5th and 14th flagellar segments of male; e - 5th flagellar segment of female; f - wing of male; g - tarsal claws of female.

broad with subcosta closely adjacent to costa, 3rd vein slightly bent apically, 5th vein branched. Tarsal claws simple or with several fine subulate denticles of great varying form. Empodium small, pulvilli rudimentary. Gonocoxite short, wide and sparsely covered with hairs, the apical-ventral part extended into a scarcely discernible prominence (very marked in I. barbatum sp. n. and I. mitjaevi sp. n.). A sclerotized prominence covering the gonofurca is formed on the ventral surface by the gonocoxite. Gonostylus greatly narrowed apically and approximately half the length of the gonocoxite. Dorsal plate sclerotized with rounded, clearly delineated flabella. Parameres as long as the dorsal plate but much narrower and with more rounded flabella.

Female. Length 3.0-3.5 mm. Antennae 2 + 13-14. Flagellar segments almost cylindrical, longer than broad, without setae, gradually and uniformly narrowed apically. Terminal segment sometimes long because of fusion, sometimes short; 1st, 2nd and sometimes 3rd flagellar segments covered with dense setae, which form a proximal whorl on the other segments. Circumfili forming a band of interconnected irregular cells. Tarsal claws with denticles normally small and subulate; similar to the claws of I. dentipes sp. n. The blunt ovipositor, which is uniformly covered by short setae, has two small circular flabella separated by an even smaller one.

Close to I. dentipes, sp. n., from which it is clearly distinguished by the circumfili on the flagellar segments in both males and females, and more clearly by the male genitalia: shorter gonostylus, rounded external edge of the flabella of the dorsal plate and shorter parameres.

Described from 10 males and 17 females.

Damages Tamarix ramosossima, T. gracilis, T. leptostachys. Forms galls (Fig. 13, c) on fine twigs as small globular swellings 6-9 mm long, often arranged as beads. Each gall contains 1-4 larvae.

Isosandalum noxium Marikovskij, sp. n. (Fig. 5).

Male. Length 2.9-3.2 mm. Antennae 2 + 15. Last antennal segment small and conical, but sometimes extended. Flagellar segments with rounded nodules and a group of randomly distributed setae on the distal half. A single band of circumfili on each segment below the middle. Empodium and pulvilli of equal length, scarcely half that of the claws; the pulvilli often covering a small denticle of the claw which is not always easily discernible. Gonocoxites short, broad and protuberant, sparsely covered with hairs. The ventral-basal angle of the gonocoxite forms a large prominence with fine hairs that cover the gonofurca. The apices of these prominences have jagged edges. The broad short gonostylus is toothed and half the length of the gonocoxite.

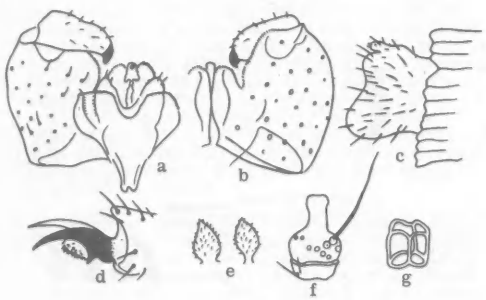

Fig. 5 - Isosandalum noxium, sp.n. a - hypopygium from above; b - hypopygium from below; c - ovipositor; d - tarsal claws of female; e - palpi; f - 2nd flagellar segment of male; g - circumfili of 2nd flagellar segment of male.

The dorsal plate has a rounded recess and wide flabella with rounded or slightly truncated apices. Parameres narrower than the dorsal plate, with a deep and wide emargination and digitiform flabella that are slightly narrowed apically. The parameres greatly narrowed basally. The dorsal plate, parameres and flabellum of the gonocoxite highly sclerotized.

Female. Length 3.0-3.5 mm. Number of antennal segments variable: 2 + 12-14, according to whether the terminal segment is fused or not and short (2 + 14) or long (2 + 12). Elongated-oval 1st flagellar segment carrying a sparse group of setae; following segments cylindrical, sessile, gradually shortening apically and generally with one whorl of setae each. At least on each of the central funicular segments the circumfili form 4 honeycomb cells encircling the segment. Ovipositor short, soft and indistinct, blunt at the apex and with two very small extended flabella on the dorsal side at the end, below which the rudiments of two additional adjacent flabella covered with pile can sometimes be discerned.

It is clearly distinguished from the preceding species by the form of the dorsal plate, the parameres and the prominences of the gonocoxites that encircle the gonofurca.

Obtained from various districts in the Ili basin and also by the author from the Bukhara region (Uzbekistan) and southern Turkmenia.

Described from 22 males and 56 females.

It forms light ocher yellow galls (Fig. 13, d). These galls are slightly wrinkled and irregularly spindle-shaped, 2-3.5 cm long and 1 cm wide. They are woody and multichambered and are found on fine twigs. The larvae overwinter in the galls, which form in the summer. Pupation takes place in the spring in the gall. The insects fly in the spring. There is one generation a year.

This gall midge does great damage to several species of tamarisk (Tamarix gracilis, T. ramosissima, T. leptostachys) in the lower and middle reaches of the flood plain. The number of galls on a plant can be so great that its appearance becomes changed and it is greatly weakened or shrivelled.

DASNEURIOLA MARIKOVSKIJ, gen. nov.

This genus belongs to the tribe Dasyneurini of the subfamily Itonidinae; in the structure of the male genitalia it is akin to the genus Dasyneura, which contains many species, but it is clearly distinct in having two-segmented palpi, bifurcated tarsal claws and a comparatively short ovipositor.

Eyes holoptic. Antennae 2 + 12-14, the segments pedunculate in the male, sessile in the female. Scape conical, pedicel globular. Palpi two-segmented and long. Wings transparent; subcosta merging with costa in the middle of the anterior margin of the wing; 5th vein branched, the anterior branch not complete. Tarsal claws bifurcated, i.e., with one large tooth a little smaller than the claw itself. Hypopygium sharply folded to the dorsal surface, with a large dorsal plate. Ovipositor telescopic.

Generic type, Dasyneuriola suaedae, sp. n.

Dasyneuriola suaedae Marikovskij, sp. n. (Fig. 6).

Male. Length 2.0-2.8 mm. Thorax and abdominal tergites dark brown. Peduncles of flagellar segments long, almost twice as long as the nodules. Circumfilum forming a band above the basal whorl of setae. First segment of palpus half the length of 2nd and seated on a very small, scarcely discernible, palpiger; second segment long, narrow and slightly sclerotized. Tarsal claws bifurcated with a thick tooth, broad short empodium and narrow pulvilli. Empodium and pulvilli shorter than claws. Gonocoxite with base greatly truncated dorsally, sparsely covered with setae. Gonostylus slightly more than half as long as the gonocoxite, slightly tapering and with a serrated claw. Dorsal plate large, membraneous, with a deep triangular

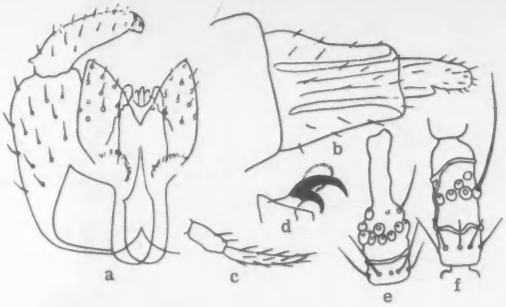

Fig. 6 - Dasyneuriola suaedae, sp.n. a - hypopygium from above; b - ovipositor; c - palp of male; d - tarsal claw of male; e - 5th flagellar segment of male; f - the same in the female.

groove and pointed flabella extending almost to the apex of the gonocoxite. Parameres narrow, linear, with a deep rounded groove and narrow digitiform flabella. Gonosterni large, tapering in steps to the apex.

Female. Length 2.0-2.5 mm. Antennae 2 + 12-13. Flagellar segments cylindrical, sessile, gradually shortening apically, 1st and 2nd fused. Circumfili forming two bands connected by a longitudinal crosspiece on each segment. A regular whorl of setae at the base of each flagellar segment. The form of the terminal flagellar segment is variable and it may be either short or long; in the latter case there are traces of the fusion of two segments. The terminal lobes of the ovipositor regularly oval, covered with sparse short setae and separated by an indiscernible medial flabellum.

Described from 2 males and 14 females from the flood plain of the middle reaches of the Syr-Dar'ya (South-Kazakhstan region) where galls form on Suaeda microphylla (Fig. 13, e).

The galls, which are found at the apices of shoots, are globular, juicy, green, thin-walled structures with an extended domed apex. Several larvae live in the large cavity. The plants are heavily infested. The gall grows in the early spring and pupation takes place in the gall. Flight occurs in the first half of May and there is one generation in a year.

Dasyneuriola tamariciphila Marikovskij, sp. n. (Fig. 7).

Male. Length 2.0 mm. Antennae 2 +14. First and 2nd flagellar segments fused; peduncles of flagellar segments as long as, or longer than, the nodules, but that of penultimate segment is short. Terminal segment ovate. Circumfili forming one band in the basal half of each nodule. Palpi small, two-segmented and covered with fine pile, the segments of equal length. Tarsal claws bifurcated. Pulvilli rudimentary, empodium considerably shorter than claws. Gonocoxite covered with short sparse setae and with an almost smooth outer edge. Gonostylus half the length of the gonocoxite. Dorsal plate large and broad, and with a deep narrow rounded groove and slightly tapering flabella. Parameres as long as but considerably narrower than the dorsal plate, with a small rounded groove, and greatly contracted at base. Gonosterna tightly encircling the gonofurca, conical and covered with thick pile.

Clearly distinguished from the preceding species by the chaetotaxy of the palpi, the considerably smaller and somewhat different dorsal plate and the more oval nodules of the funicular segments.

Described from 1 male.

Reared from isolated galls on green tamarisk twigs, where it is found with Isosandalum dentipes sp. n.

It is still not clear whether this species is symbiotic or whether it has a separate existence in green tamarisk twigs.

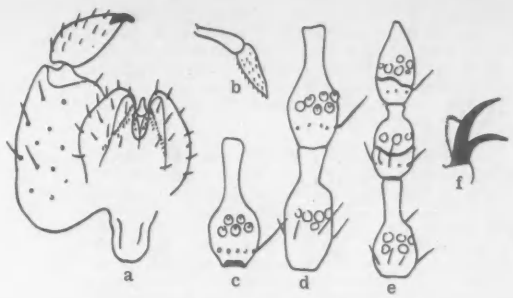

Fig. 7 - Dasyneuriola tamariciphila, sp.n. a - hypopygium from above; b - palp of female; c - 5th flagellar segment of male; d - 1st and 2nd flagellar segments of male; e - 12th-14th flagellar segments of male; f - tarsal claw of male.

Rusaamenia harundinea Marikovskij, sp. n. (Fig. 8).

Male. Length 1.8-2.0 mm. Antennae 2 +14-17. Peduncles of flagellar segments almost as long as nodules. First and 2nd flagellar segments not fused. Terminal flagellar segment with a strobiloid appendage. Circumfili forming a band slightly below the middle of the nodule, which is slightly narrowed beneath the band. There are three whorls of setae, of which the lower and upper whorls consist of fine setae, and the central whorl of two irregular rows of large setae extending outwards almost at right angles. Palpi four-segmented and covered with sparse hairs. First palpal segment narrow and curved, 2nd broad and short, 3rd and 4th long and of equal dimensions.

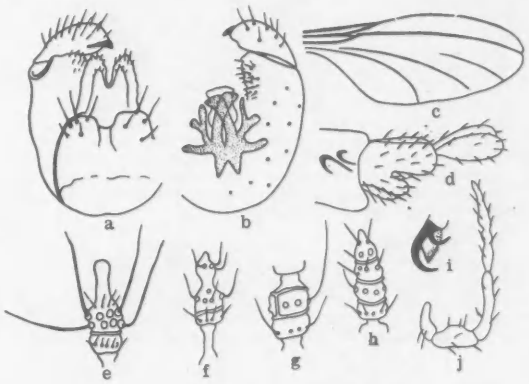

Fig. 8 - Rubsaamenia harundinea, sp.n. a - hypopygium from above; b - hypopygium from below; c - wing of female; d - ovipositor; e - 5th flagellar segment of male; f - terminal flagellar segment of male; g - 5th flagellar segment of female; h - terminal flagellar segment of female; i - claw of male; j - palp of male.

Wings narrow and well-proportioned. Subcosta merging with costa in the middle of the anterior margin, 3rd vein terminating apically, where the costa ends. The vein connecting the 3rd vein and the subcosta parallel to the anterior margin of the wing. Only the end of the 4th vein preserved, terminating subapically; the 5th and 6th veins simple, the former disappearing towards the base. Tarsal claws bifurcated, the denticle on the inner claw sometimes missing. Empodium shorter than claws, pulvilli absent. Tip of abdomen sharply bent to the dorsal surface. Gonostyli with straight inner and curved outer edges and a long, serrate claw. Gonocoxite with base sharply tapered from the dorsal side. Dorsal plate with a deep groove,

the apices of the flabella rounded off. Parameres smaller than, and of same shape as, dorsal plate and covered by it. The 8th sternite forms an additional plate which is often lost in preparation and mounting of the genitalia. The gonosternum presents a complicated picture of overlapping plates and processes.

Female. Length 2.5-3.0 mm. More variation in number of flagellar segments than in male, 2 + 10-18. When the number of segments is small, the terminal segments are often fused. Flagellar segments almost cylindrical with very small peduncles. Two bands of circumfili linked by two longitudinal bands. Two whorls of setae on each segment. The last four abdominal segments long, narrow and cylindrical. As in the male the tip of the abdomen is greatly curved to the dorsal surface. Ovipositor two-segmented. Terminal flabella elongate oval with thin pedicels. The basal flabella have additional prominences.

The species described differs from known species of the genus in that the 5th vein disappears towards the base, the 3rd vein terminates apically and not subapically and the gonostylus is different in shape.

Described from 12 males and 12 females from the district of the middle reaches of the Ili River (Kazakh SSR). Larvae live in the leaf axils of reed. They are also often found in the shortened stems of the galls of Lipara lucens Mg. (Chloropidae), also on reed.

CAREOPALPIS MARIKOVSKIJ, gen. n.

This genus belongs to the subfamily Itonidinae and the tribe Lasiopterini.

The parietal part of the head is sagitally compressed. Antennal segments sessile, with small tubercles on the ventral surface; 1st and 2nd flagellar segments fused. Palpi absent and mouth parts consisting of a reduced labrum in the form of a beak-like protuberance and a semicircular labium. Tarsal claws without denticles, simple or with scarcely perceptible toothlike protuberances at the bases. Empodium shorter than claws. Subcosta terminating a little before the middle of the anterior margin of wing; 4th and 5th veins simple. Dorsal plate round with a slight groove at the apex. Parameres spatulate and without grooves. Terminal flabella of the ovipositor irregularly oval, with a subulate appendage curving towards the ventral side and without long setae or spines.

The genus is similar to the genera Baldratia Koeff., Haloxylomyia Marik. and Haloxylophaga Marik., but is clearly distinct from them in the absence of palpi, the unusual form of the head, the chaetotaxy of the subulate appendage of the ovipositor and the simple claws. Gall midges without palpi are only known in the genus Oligarces Mg. of the subfamily Heteropezinae.

Generic type Careopalpis anabasidis, sp. n.

Careopalpis anabasidis Marikovskij, sp. n. (Fig. 9).

Male. Length 2.5 mm. Antennae 2 +10. Flagellar segments decreasing very slightly in length towards the end of antenna, almost barrel-shaped, with proximal end more tapered; terminal segment oval. Circumfili forming two bands in the distal half of the segment, connected by longitudinal bands. Two whorls of setae on the funicular segments, the proximal whorl consisting of short, and the distal of long, setae. Gonocoxites strongly curved outwards and covered with sparse hairs. Gonostyli half the length of the gonocoxites, tapering apically and with a serrate claw. Dorsal plate long, broad, slightly grooved. Parameres considerably shorter than dorsal plate, without grooves and uniformly rounded at apex. Gonosterna conical, uniformly tapering apically and covered with thick fine hairs.

Female. Length 3.0 mm. Antennae as in male, except that 1st and 2nd segments are more noticeably separated by a constriction and not so clearly fused, and the bands of circumfili are more wavy. Terminal flabella of the ovipositor oval and covered with sparse short setae. Subulate appendage closely adjacent to terminal flabellum of ovipositor and bearing a regular row of very fine delicate setae, the length of which is less than the diameter of the subulate appendage.

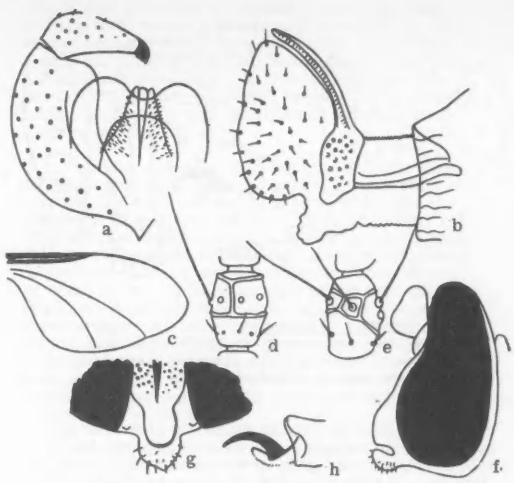

Fig. 9 - Careopalpis anabasidis, sp.n. a - hypopygium from above; b - ovipositor; c - wing of female; d - 5th flagellar segment of male; e - the same for the female; f - profile of head; g - frontal view of head; h - claw.

Described from 16 males and 41 females from the district of the middle reaches of the Ili River (Kazakh SSR). Forms galls on Anabasis aphylla. The galls (Fig. 13, f) are 4-10 mm long, 3-5 mm in diameter. Green at first, but subsequently turning brown, they are irregular swellings of the green twigs with slight outgrowths and light cross striation. There are 1-4 larval chambers closely adjacent to each other in a gall. Each chamber is a cigar-shaped case intimately bonded with the stem of the twig. The casing of the gall is brittle and the gall tissue between it and the larval chamber is delicately spongy. Wintering occurs in the gall in the larval stage. Flight, copulation and egg laying take place in the spring. The galls grow slowly throughout the summer and autumn. There is one generation a year. Galls are quite abundant.

Janetiella gemmicola Marikovskij, sp. n. (Fig. 10).

No galls had previously been known to exist on winter fat (Eurotia ceratoides), which is a widely distributed desert shrub.

Male. Length 2.5-3.0 mm. Number of antennal segments varying between 2 +12 and 2 +16. Flagellar segments pedunculate, the length of the peduncles gradually increasing nearer the apex of the flagellum. Circumfili poorly developed and consisting of one band in the basal third of each nodule. Terminal segment of variable form (Fig. 10). The 1st and 2nd segments are also sometimes of variable form and occasionally elongated and fused. Variation in the form and number of these segments is a distinctive feature of the species. Palpi four-segmented. First segment noticeably more sclerotized than the others. 1st and 2nd segments broader and shorter than 3rd and 4th. Tarsal claws simple. Empodium half the length of the claws. Pulvilli narrow, long, of the same length as the claws. Subcosta terminating in middle of anterior margin of wing. Third vein almost straight, terminating subapically. Fifth vein also almost straight with a slightly curved branch. Gonocoxite with a rounded groove on the lower inner edge, covered with sparse setae; outer edge almost straight. Gonostylus slightly more than half as long as the gonocoxite, with a simple,

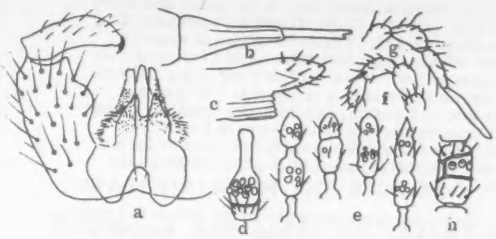

Fig. 10 - Janetiella gemmicola, sp.n. a - hypopygium from above; b - ovipositor; c - tip of ovipositor; d - 5th flagellar segment of male; e - variations of terminal flagellar segments of male; f - palp of female; g - palp of male; h - 5th flagellar segment of female.

slightly curved claw. Dorsal plate with a rounded groove and broad flabella slightly tapering apically. Parameres considerably narrower than dorsal plate, with pointed narrowed flabella. Membranous rounded gonopleurites beneath the dorsal plate, strewn with short outward-pointing hairs. Gonosterna narrow, long and covered with short hairs. Gonofurca bottle-shaped.

Female. Length 2.5-3.5 mm with ovipositor retracted. Antennae 2 +12-14, usually 2 +13. Flagellar segments cylindrical, sessile and each with circumfili in two indistinct bands and with two whorls of short setae. Terminal segment either short or long when formed by the fusion of two segments. First and 2nd flagellar segments sometimes weakly fused. Segments in the middle of the flagellum fused, usually asymmetric. Flagellar segments thick and pear-shaped. Pulvilli and empodium shorter than in male. Abdomen slender and elongated. Ovipositor telescopic, extended, 2/3rds as long as the abdomen, bearing two lanceolate lobes separated by a small unpaired lobe.

Described from 11 males and 22 females from the stony desert near the Anarkhay range in Southeastern Kazakhstan. This species gives rise to galls (Fig. 13, g) that are bud growths 4-9 mm in diameter. Each gall is composed of triangular scales covered at the upper edges with fine downy white hairs. From 3 to 19 bright red larvae live between the scales of the gall. Flight occurs in early spring. The gall grows throughout the summer and autumn. In late autumn the larvae enter the soil where they pupate. Wintering takes place in the soil. The larvae are greatly infested by ichneumon flies. There are few galls on winter fat.

Contarinia desertorum Marikovskij, sp. n. (Fig. 11).

Male. Length 2.0 mm. Light ocher. Antennae 2 +12, 2/3rds the length of the body. Flagellar segments with two identical nodules separated by a neck that is slightly shorter than the peduncle. The wide loops of the circumfili reaching the base of the nodule above; a whorl of setae below each whorl of circumfili. Apical nodule of terminal segment conical. Palpi consisting of four thick segments, the last of which is further thickened and has indications of false segmentation. Tarsal claws simple, sickle-shaped. Empodium of same length as claws, pulvilli rudimentary. Subcosta merging with costa almost in the middle of the anterior margin of wing; 3rd vein terminating apically, sometimes failing to reach the apex and interrupting the costa where the latter curves; 5th vein with a sharply curved branch. Gonocoxite almost cylindrical, covered with sparse hairs. Gonostylus long, almost bare, with a simple claw, and 2/3rds the length of the gonocoxite. Dorsal plate with a deep slit and rounded flabella that are slightly scalloped at the apex. Parameres slightly longer than dorsal plate, with a broad deep groove and narrow flabella. Gonofurca in the shape of a broad cone. Gonosternum not developed.

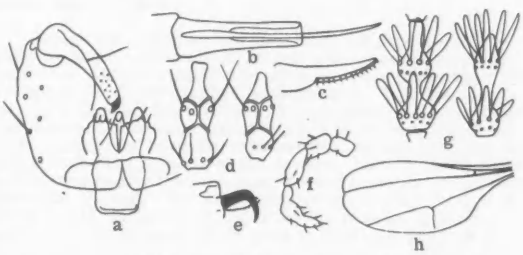

Fig. 11 - Contarinia desertorum, sp.n. a - hypopygium from above; b - ovipositor; c - tip of ovipositor; d - 5th and terminal flagellar segments of female; e - tarsal claw of male; f - palp of male; g - 5th and terminal flagellar segments of male; h - wing of male.

Female. Length 2.0-2.5 mm with ovipositor extended. Well defined peduncles on the almost cylindrical antennal segments, which have a noticeable constriction in the center. Two bands of circumfili connected by two longitudinal threads. Two whorls of hairs. First and 2nd flagellar segments elongated and fused. Terminal segment of the flagellum conical. Ovipositor long, telescopic, pointing forward, as long as the abdomen. Terminal lobes long, narrow and pointed, each with a row of very delicate short hairs on the inner edge.

Described from 3 males and 112 females from the loess desert of Dar'yalyk in the Kzyl-Orda region. The highly mobile white larvae form leaf galls on camel's thorn (Alhagi pseudalhagi - Fig. 13, h). The gall is a slightly thickened leaf rolled up along the central vein and firmly secured at the edges by a scarcely perceptible suture. The gall cavity contains 20-40 larvae. When emerging from the gall the larvae congregate at the suture which bursts and allows the leaf to unfold. The larvae bury themselves in the soil, where they pupate. The pupal stage lasts for approximately two weeks, after which the pupae reach the surface and the midges fly away. There are several generations in the year. Plants are not greatly infested.

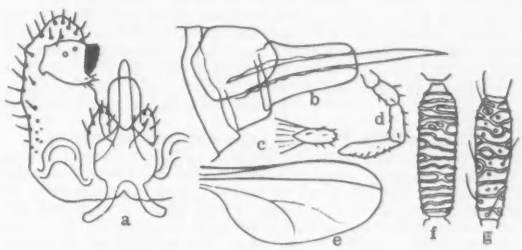

Fig. 12 - Polystepha vicina, sp.n. a - hypopygium from above; b - ovipositor; c - tip of ovipositor; d - palp of male; e - 5th flagellar segment of male; f - the same for the female.

Polystepha vicina Marikovskij, sp. n. (Fig. 12).

Male. Length 1.8-2.5 mm. Abdomen red, thorax, legs, abdominal tergites and sternites dark brown, almost black. Antennae 2 +12. Flagellar segments almost cylindrical in form with a scarcely noticeable peduncle and 15-18 belts of circumfili some of which branch or form cross-bands. Length of 1st segment 4 times greater than its breadth and of central segments 3 times greater. Palpi four-segmented. Tarsal claws simple, empodium shorter than claws. Subcosta terminating in middle of wing margin; 3rd vein terminating in apex of wing and interrupting costa; the thickness of the costa and the 3rd vein greatly reduced from the point at which they merge; 5th vein forked and weakly developed. Gonocoxite almost cylindrical, evenly rounded at the apex, covered with short setae. Gonostylus subapical and short with a truncated apex carrying a serrate claw above a slight prominence. Dorsal plate thick and deeply bisected, with setae on the inner surface of the flabella. Parameres longer than dorsal plate, cylindrical and with rounded apices, their bases highly sclerotized and

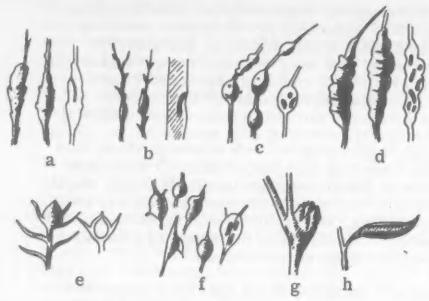

Fig. 13 - Galls. a - Isosandalum barbatum, sp.n.; b - I. dentipes, sp.n.; c - I. iliense, sp.n.; d - I. noxium, sp.n.; e - Dasyneuriola suaedae, sp.n.; f - Careopalpis anabasidis, sp.n.; g - Janetiella gemmicola, sp.n.; h - Contarinia desertorum, sp.n.

bearing two divergent processes. Gonofurca thin and cylindrical and slightly raised above the dorsal plate.

Female. Length 2.0-2.5 mm. Antennae 2 + 10. Flagellar segments almost cylindrical, broadening slightly and evenly towards the apex. First flagellar segment almost three times as long as the terminal segment. Circumfili considerably finer and more delicate than in the male and much more interjoined. Fewer flagellar segments than in the male (9-12). Terminal segment slightly clavate with a clear indication of the fusion of two segments and with an even finer and more delicate honeycomb structure of circumfili. Ovipositor telescopic and sharply pointed, the terminal lobes fused to form one small lobe covered with fine setae. The 8th tergite greatly enlarged to form a rounded sclerotized plate with short setae at the apex.

The only known representative of the genus Polystepha, to which the new species has been ascribed, was described from Germany in 1913 on an oak.

P vicina, sp. n., which was extracted from galls on the salt bush Kochia prostrata along with the gall midge Asiodiplosis vicinus Marik., was collected in the loess desert near the Karatau range in the Dzhambul Region. We were not able to determine whether this species forms galls independently or whether it is merely symbiotic with A. vicinus. The galls, which are found at the end of shoots, are white curved globules composed of fine hairs. Pupation occurs in the gall and flight is at the end of June. There is apparently only one generation a year.

The new species is clearly distinguished from P. quercus Kieff. by its greater size, larger number of circumfiliar bands on the antennal segments and by the form and size of the dorsal plate and parameres.

Described from 7 males and 13 females.

MATERIALS ON THE BIOLOGY OF GALL MIDGES (DIPTERA, ITONIDIDAE) THAT ARE PESTS OF TAMARISKS IN SOUTHEASTERN KAZAKHSTAN

I. D. MITYAYEV

Gall midges are a significant factor in the insect pests which I have collected from tamarisks in southeastern Kazakhstan. The composition of these insects by species and, even more so, their biology, were completely unstudied until quite recently. Almost all the gall midges that I have found on tamarisks have been species that were hitherto unknown to science.[1] Nevertheless some of them are capable of bursts of large-scale breeding and of causing very serious damage to tamarisks.

The Noxious Tamarisk Gall Midge - Isosandalum Noxium Marik. (Fig. 1, 1-3)

The galls of this genus are light ocher or yellow, elongated or cylindrical, straight or curved growths with a rough surface that occur at the ends of twigs (Fig. 1). The length of the gall, dependent on the number of larvae which it contains, varies between 12.0 and 40.0 mm, and the diameter between 3 and 10 mm. One often encounters galls covered by small green sprigs that drop off in the late fall or by bud-shaped excrescences (Fig. 1c) that are the galls of I. iliense Marik.

There are from 6 to 30 longitudinal larval chambers within the gall. The chambers which normally lie longitudinally and less frequently transversally, are separated from each other by walls of varying thickness. Slightly unusual galls with a smooth-surfaced dark red globular base are sometimes encountered. These are formed by the fusion of the galls of the noxious tamarisk gall midge with those of Amblypalpis tamaricella Dan. This occurs when the caterpillar of the moth, which gives rise to its own gall, colonizes a bud or twig already inhabited by gall midge larvae. The coincidence of the habitats (fusion of the galls) of the larval stages of these two species leads almost invariably to the partial or total destruction of the gall midge larvae. Once installed in the gall midge gall the caterpillar rapidly devours the succulent tissues and destroys the larval chambers, thus depriving the larvae of food and normal living conditions.

Wintering occurs in the gall in the larval stage. Pupation commences in the spring, also in the gall, and coincides with the commencement of bud formation on the tamarisks on which these gall midges develop. Pupation, which normally takes 2-3 days, takes place at the same time for all the larvae. This normally occurs about April 25th in the middle reaches of the Ili River. The pupae take 4-5 days to develop.

The midges take flight from the galls at the end of April; as with pupation this is a mass movement which does not last longer than 2-3 days.

Before the emergence of the imago the pupa bores a flight passage in the wall of the gall with a special drilling apparatus, but the midges only emerge 10-30 hours after the drilling of the flight passage is completed. This time is clearly necessary for the imago to complete its development. The pupa protrudes approximately 3/4 of its body out of the flight passage by wormlike movements. At this time the skin on the back bursts and first the dorsum, then the head of the midge, and finally the fore legs, appear from the longitudinal split thus formed. The midge grasps the uneven surface of the gall with its fore legs and frees the remaining parts of its body. The appearance of the pupa in the flight passage and the emergence of the midge take place fairly rapidly — in the space of 2-3 minutes. The freed midge remains on the surface of the gall or moves to a branch close at hand. Here it spreads its wings and dries out.

The majority of newly emerged females are unable to fly even for very short distances. They cannot fly upwards or across to a neighboring bush or to the nearest branch of the plant. If some of them do fly up they sink gently down to the underlying branches or to the ground. It appears that these females are unable to fly because of the great weight of the egg-filled abdomen. Their fecundity varies between approximately 370 and 400 eggs. When they are subsequently relieved of a considerable number of their eggs and are thus lighter in body they can fly quite easily from branch to branch and from plant to plant. Only very few females could fly more or less easily immediately after hatching. In this case there were not more than 370 eggs in their egg tubes.

The males fly well. They fly easily and rapidly from branch to branch and from one tamarisk to another in search of females ready for mating. Mating begins at about six in the morning and is most active by eight o'clock. In preparation for mating the females sit motionless on the branches, slightly protruding the ovipositor. Having found a female, the male approaches her from the side and clasps her ovipositor from beneath with the hypopygium. Copulation lasts 1 1/2 - 2 minutes. After copulation the male flies off to find another, as yet unfertilized female.

As soon as the male quits her the fertilized female draws in the ovipositor and moves up or down the branch in search of opening buds. When she finds a bud she ascends it, puts her head down, folds the tip of the abdomen under her and uses the extended ovipositor to seek out the position of a fold. If no eggs have been laid in the bud by other females of the same species she begins to lay. The female first protrudes the egg half way out of the ovipositor and holds it in this position for 2-3 seconds. After this she fastens the free portion of the egg to the surface of the bud and frees the remaining half of the egg by drawing the abdomen backwards. The secretion of the colleterial glands, which covers the surface of the egg, thickens and becomes adhesive after 3-4 seconds in the air. This makes it possible to fasten the egg securely to the surface of the bud.

The eggs are laid in several rows on the outer side at the apex of the bud. A row normally consists of six closely adjacent eggs. The second and subsequent rows are often laid against the preceding rows. Between 1 and 30 eggs, but usually 12-24, are laid on one bud. A single female lays between 270 and 400 eggs in 6-12 hours. When they have finished egg laying the females become feeble and semi-motionless and soon perish.

The larvae hatch on the third or fourth day after the completion of egg laying and immediately penetrate into the bud. They grow and develop throughout the spring, summer and autumn and when the cold spells arrive in the late autumn they stop feeding and enter the diapause. The noxious tamarisk gall midge thus has one generation a year.

The bud into which the larvae have penetrated develops at first as a normal green twig and it is half a month before a barely perceptible thickening — the gall containing the larvae — appears at its tip. The gall grows and develops in pace with the growth and development of the larvae and reaches its normal size by the end of the summer. The gall becomes slightly shrivelled in the autumn and acquires a light ocher or yellow color.

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[1] P. I. Marikovskiy has classified the species. I wish to take this opportunity of expressing my deep gratitude to him.

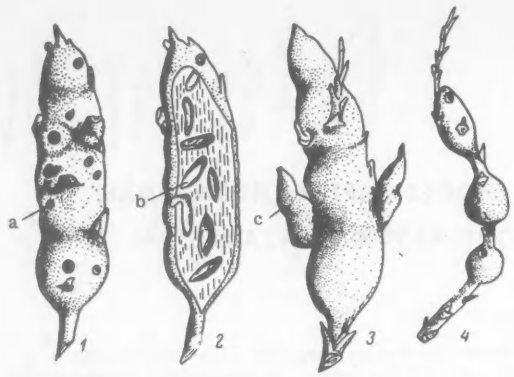

Fig. 1 - 1 - 3 - Galls of the noxius tamarisk gall midge (Isosandalum noxium Marik.): a - flight passage, b - larval chamber, c - gall of Ili gall midge (Isosandalum iliense Marik.) on gall of noxious gall midge; 4 - galls of Ili gall midge (Isosandalum iliense Marik.).

The noxious tamarisk gall midge is mainly found on sparse tamarisks growing on riparian sands or in salt marshes. It is also found occasionally on tamarisks in dense forest scrub close to water.

In the Balkhash-Alakul depression the noxious tamarisk gall midge is most numerous in the basins of the Ili and Kara-Tal Rivers. In the years when we conducted our investigations there were local variations in the numbers of this pest, due largely to the activity of parasitic hymenoptera (Chalcididae and Proctotrupidae), the larvae of which destroyed the gall midge larvae.

As with certain other insect pests of tamarisks, abundance breeding and scarcity occurred at different times in different parts of their area. Whereas breeding was most intensive in the flood basin of the lower Ili in 1953 (the area between Bakanas and the sixth fishing point) it had already declined in the valley of the middle Ili (between the mouth of the Kurta and Bakanas), although this was not yet apparent from the level of infestation of the plants. In the basin of the upper Ili (Borokhudzir) the noxious tamarisk gall midge was greatly depressed. The beginning of a spurt in mass breeding was apparent along the Kara-Tal in 1954.

An analysis of samples to test the infestation of the larvae by ichneumon flies at these four points shows that the larvae were subjected to attack by various species of parasites and that the overall level of infestation was highly dependent on conditions at the center of infestation (see the Table).

The pests were most infested with parasites at the focus where the population was on the decline and least infested at the center, where it had already reached the extreme ebb. In the latter focus the number of gall midges was so low that we were only able to find a few new galls in quite a large area of tamarisks. At the same time we found shrivelled or semi-shrivelled tamarisks strewn with old galls everywhere we went. This shows that the gall midge had been present en masse in previous years. Along the Kara-Tal the spurt in mass breeding had apparently taken place somewhat earlier, since most of the old galls had already dropped off and new galls were found quite frequently. Between 40 and 73 galls were found on some bushes. Infestation of the larvae by ichneumon flies was low, although almost half as great again as in the upper reaches of the Ili. All this shows that the pest had emerged from the state of depression and that its numbers were rising rapidly.

The most numerous of the ichneumon flies to infest the noxious tamarisk gall midge is the chalcid fly — Eupelmus sp. It emerges from an old gall after the gall midges have flown and when new galls are beginning to be formed. Since the galls are small at this time and most of the gall midge larvae are close to the surface, the female chalcid fly is able to bore through the surface of the gall and lay its eggs in the body of the larva despite the shortness of its ovipositor. One egg is laid in each larva. The larvae that are deepest in the gall often escape infection since the females are often unable to reach them with their ovipositors. The fecundity of female chalcid flies and the number of larvae they infect has not yet been established. On hatching, the chalcid fly larvae attach themselves closely to the body of the gall midge larva and suck outs its body fluids. The larvae of the chalcid flies grow relatively slowl during the summer and it is only in the fall, when the gall midge larvae reach maximum size, that the chalcid fly larvae develop rapidly. During the period of rapid growth of the chalcid fly larvae the gall midge larvae are greatly weakened and some perish by the late fall, but the majority overwinter more or less successfully with the chalcid fly larvae. On emergence from the state of diapause in the spring the chalcid fly larvae continue to feed and grow and leave only the skins of the gall midge larvae by the time they pupate.

The flight time of another parasite, Platygaster sp., coincides with that of the noxious tamarisk gall midge. The females of this species of ichneumon fly lay their eggs in the eggs of the gall midges. The larvae develop in the body cavity of the gall midge larvae. In the autumn they eat their contents and remain to winter in the gall. After overwintering the larva transforms into the pupa and then into the imago in the early spring.

No single parasite succeeds in breaking out of the gall: the shrivelled walls harden and clearly form an impassable barrier. It should be noted that both the walls of the gall and the comparatively thin and transparent integument of the gall midge larvae remain completely untouched, i.e., are not gnawed. The adult ichneumon fly lives for 7-12 days in the integument of the gall midge larva, becomes comatose and perishes without giving rise to progeny. Thus when this species of parasite develops in the larvae of the noxious tamarisk gall midge it does not complete its biological cycle.

It would therefore seem at first glance that the numbers of the ichneumon fly should decrease to some extent year by year. Observations show, however, that instead of declining they have increased. Thus in 1953 infestation was 32% in larvae along the middle reaches of the Ili River. In 1954 in

Sample taken from and state of focus	Number of larvae analyzed	Overall infestation of larvae by ichneumon flies (%)	Distribution of overall infestation by species of ichneumon fly (%)			
			Eupelmus sp.	*Tetrastichus* sp.	*Callimome* sp.	*Platygaster* sp.
Lower reaches of the Ili River (Bakanas — 6th fishing point), outbreak at its height	220	37.0	16.0	13.0	3.5	4.5
Middle reaches of Ili River (mouth of Kurta River — Bakanas), focus extinct	234	77.0	42.8	1.2	1	32
Upper reaches of Ili River (Borokhudzir), depression	198	7.0	7.0	—	—	—
Kara-Tal, commencement of outbreak	207	13.0	4.9	8.1	—	—

the same locality (galls collected from the same shrubs) infestation had risen to approximately 40%. The explanation must clearly be that the parasite develops on other hosts and that there are several generations in a year. The nuptial period and the laying of the spring generation coincides with the flight of the noxious tamarisk gall midge and it also clearly parasitizes its eggs. This part of the population is therefore doomed to perish. The numbers of the species are probably maintained by the populations that develop on other hosts. Thus one can conclude from this slight amount of information on the life of this ichneumon fly that there is clearly a quite persistent "error" of instinct.

In the remaining species of parasites — Tetrastichus sp. and Callimome sp. — the developmental cycle on the larvae of the noxious tamarisk gall midge is similar in general features to that of Eupelmus sp.

Various predators also have a quite noticeable effect in reducing the numbers of the noxious tamarisk gall midge. Thus the female is often attacked during oviposition by a small spider, Philodromus pictus Croneb. This spider ambushes its prey, choosing for this purpose secluded spots in the upper part of the crown of the plant at the bases of the twigs. Here it awaits its prey and normally attacks females that appear below its ambush. As soon as the gall midge appears near the predator the latter immediately retracts all its legs and remains still. As soon as the female adopts the laying position the spider rushes down onto its victim. The spider then returns with its prey to its former position, entangles it with web, fastens it to a twig and continues hunting. The predator apparently only eats when it has caught a considerable number of its prey. If one makes a careful examination of the crowns of tamarisks a little after the flight of the gall midge has ended one can always find the remains of gall midges in spider web hanging on the twigs.

A symbiont of the noxious tamarisk gall midge, the weevil Apion sp., has been discovered. Two generations a year develop in the gall of the noxious tamarisk gall midge. The larvae winter in the gall in their individual chambers. Pupation occurs in the gall in the middle of the first ten days in July. The pupa takes 4-5 days to develop. After transforming the beetle gnaws a flight passage and quits the gall. The beetles emerge from old galls when the new galls are green and at their most succulent stage, without any signs of drying out. This feature in the biology of the weevils has most probably arisen in connection with life in galls. It is essential to it since the weevil causes great damage to the gall when it settles in it. It stands to reason that the tissues of green succulent galls are in the best position to repair the defects caused by the beetle and the larvae. Otherwise the gall might die too soon and thus lead to the death of the gall midge and weevil larvae.

The beetles normally sit on or near the galls, where they also copulate. The female prefers the largest and juiciest galls for egg laying. For this purpose she gnaws a pit the length and thickness of her proboscis and lays one egg in the bottom. The larva emerges on the third day after egg laying. Its development requires 4-6 days. In the first days the larvae feed and grow without making passages. In the last days they become more voracious and begin to make passages in all directions in the gall. The length of these passages does not exceed 4 mm.

There are normally 3-5 weevil larvae to a gall and it is only very rarely that 7-8 are found in the largest galls. We did not find that weevil larvae living in one gall with the larvae of the noxious gall midge had any marked injurious effect on them. They normally locate their passages between the larval chambers of the gall midge.

The first generation emerge around the 25th of July and start the second generation. Thus the first generation develops in half a month, i.e., within a very short period, at a time when the galls are growing most rapidly. The second generation larvae hatch at the end of July. They grow slowly without making passages and have chambers in the gall that are almost indistinguishable from those of the gall midge larvae. As the gall ripens the larvae cease feeding; with the commencement of winter they enter a state of diapause which continues until July of the following year.

This symbiotic weevil was discovered in the gall of an elongated tamarisk mite (Eriophyes sp.) in the basin of the upper Ili in 1953. The possibility has not been excluded that in years when there is a sharp reduction in the numbers of the gall midge the symbiotic weevil may be capable of shifting to the galls of other gall-formers on the tamarisk.

The noxious tamarisk gall midge damages polyramous, graceful and turnip-shaped tamarisk in southeastern Kazakhstan. Where its numbers are low there is little sign of damage. When there is mass breeding, however, infestation becomes so high that some plants have no twigs without galls. Greatly affected plants die by spring. Those that are less infested are weakened and vulnerable to secondary pests.

The high degree to which individual plants are affected is very marked in this species of gall midge. This is because, as has already been mentioned, the female primarily colonizes the plant on which it developed, and one can therefore find tamarisk shrubs with its galls even where the numbers of the pest are low.

The Ili Gall Midge - Isosandalum Iliense Marik. (Fig. 1, 4)

The galls are small globular or globular elongated growths 5-8 mm long and 3-4 mm in diameter on green sprigs. The Ili gall midge infests polyramous, graceful and turnip-shaped tamarisks and is found together with the noxious tamarisk gall midge and usually attacking the same plants. The larvae winter in the galls, and pupate in late April, also in the galls. The midges fly a week after the flight of the noxious tamarisk gall midge has ended, about the fifth of May. The green sprigs have grown considerably and are 6-10 cm long by this time. The females lay 3-7 eggs, 1-4 cm apart, on the surface of each spring. The Ili gall midge often lay its eggs where the galls of the noxious tamarisk gall midge will form. In this case the gall of the Ili gall midge appears as a kidney-shaped excrescence 3-5 mm long and 2-3 mm in diameter on the other gall (Fig. 1, 3c).

The females can lay 307-385 eggs. On hatching, the larvae penetrate into the succulent green sprig, where they feed and grow for the remainder of the spring and the whole summer and fall, before diapausing at the beginning of winter. A small nodule, which becomes globular as it increases in size, appears within two weeks at the point where the larva entered. The gall is green and succulent throughout the summer but dries and turns yellow in the fall.

The numbers of this gall midge are small, since it is greatly restricted by the activity of parasites, including the same species of ichneumon fly that attack the noxious tamarisk gall midge. There can be a mass development in the numbers of the Ili gall midge when the parasite population is depressed. Mass infestation of particular branches and plants is also a typical feature. The branches infested by the gall midge die in the spring and the plant is noticeably weakened.

The Bearded Gall Midge - Isosandalum Barbatum Marik. (Fig. 2)

The gall is an elongated globular growth 4-5 mm in diameter and 7-8 mm long, with a blunt or slightly pointed tip, formed from the spring. The surface is rough and sometimes covered with fine green scales. The galls are found at the apex of green twigs or on the wall of racemes on Tamarix elongata Ldb. In the latter case they are flower-covered elongated globular outgrowths from the raceme wall.

Initially green and succulent, the galls subsequently dry out and become hard and yellow. There is usually one larva, and less frequently two larvae, to a gall.

Nothing is known about wintering. The initial stages of gall formation are already to be seen when the green scale-like leaves appear at the end of April. The galls contain the minute light pink larvae of the gall midge, which grow rapidly and pupate on completion of their development by the middle of May. Mass pupation was observed on 15-16 May in the basin of the middle Ili. The pupa drills a flight passage in the upper wall of the gall 5-6 days after the commencement of pupation and protrudes itself half way out. The gall midge emerges from the pupa within a few minutes.

The midges flew early in the morning at sunrise on clear days in open, well warmed localities but only after 10 o'clock in thick forest scrub. The mass flight of the midges took place on 23 May in 1953 in the valley of the middle Ili. The eggs are laid at the apices of the green twigs; the greater part of the upper half of the crown of the plant is colonized. The fecundity of the females varies between 192 and 300 eggs. Egg laying terminates by midday in open

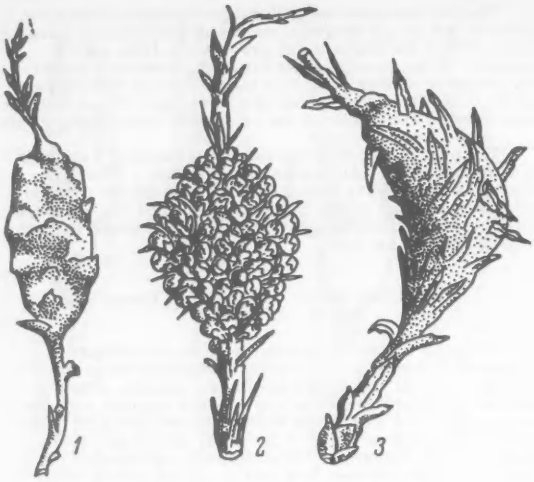

Fig. 2 - Galls of bearded gall midge (Isosandalum barbatum Marik.) 1 - typical gall with assimilated scales of the plant; 2 - gall on flower raceme covered with flowers and fruitlets; 3 - gall on flower raceme without flowers and fruitlets.

localities and by evening in forest scrub. The females die when egg laying is completed.

The beared gall midge mainly inhabits tamarisks in dense riparian thickets and is far less common in open localities. It is widely distributed in the basins of the Ili and the Kara-Tal Rivers, where it damages polyramous, graceful and turnip-shaped tamarisks. Its numbers are small due to the chalcid flies (Habrostichus sp., Tetrastichus sp. and Eupelmus sp.) that are parasitic on its larvae.

In places where these parasites are in a depressed state or not present, the bearded gall midge forms small foci of mass breeding and does noticeable damage to the tamarisks. In such localities one often finds plants of very distinctive appearance entirely covered by galls. Soon after the flight of the gall midges has ended the infested sprigs dry out and die. Badly infested plants are practically deprived of assimilating surface by the middle of the summer and are greatly weakened.

The Toothed-Claw Gall Midge - Isosandalum Dentipes Marik. (Fig. 3)

Two generations of the toothed-claw gall midge develop every year on the woody stems and green twigs of polyramous tamarisk. The second generation larvae winter in the fine woody stems of the plant. This generation does not cause gall formation: the larvae are to be found in elongated longitudinal chambers near the surface of the stem. The larval chambers are usually isolated but may be found in pairs, formed by the fusion of two isolated chambers and sometimes separated by a thin porous barrier. The walls of the larval chamber have a fine wax lining.

The larvae are unevenly distributed along the stem and are most numerous in its upper part. When the apices of the stems are thickly populated with the larvae indistinct yellowish swellings sometimes appear (Fig. 3, 2).

The larvae emerge from the diapause by about 10 April and feed and grow until pupation, during which time they increase considerably in dimensions. Pupation occurs in the larval chambers at the end of April. Flight takes place in early May and lasts for no more than three days. The midges mate soon after flight. The eggs are laid on the green twigs. The female bends the tip of the abdomen beneath her and moves up and down the stem depositing 1-2 rose-colored eggs at intervals on its surface. There are 170-212 eggs. On hatching the larvae penetrate into the sprig. In this generation they cause the formation of galls, which are small one-sided swellings on the green sprigs (Fig. 3, 1).

The larvae conclude their development in 10-12 days and pupate in the galls in mid May.

The flight of the first generation midges lasts for 2-3 days soon after 20 May. Flight commences soon after sunrise and is normally concluded by 10 o'clock. When the imago is ready to emerge the pupa easily pierces the thin shell of the gall and gradually emerges from the opening thus formed by making slow movements from side to side. When it has practically emerged from the gall cavity it fastens onto the edge of the flight passage by the tip of the abdomen and hangs upside down for 20-30 minutes. The integument over the head then bursts and the gall midge emerges from the slit thus formed, freeing its front and middle legs first and then its wings. It holds on to the edge of the slit in the pupal integument by its hind legs and continues to hang there until the wings dry and expand. Once dry the females are ready for mating and sit on the twigs. Males fly up from time to time. Copulation is brief. After several matings the female begins egg laying. She lays her eggs at random, usually on the green stem of the shrub from the apex down. Fecundity is higher than in the second generation and varies between 180 and 238 eggs. The second generation larvae emerge on the third to fifth day after egg laying. They penetrate into the succulent pulp of the green stem where they develop and grow throughout the summer and fall before diapausing at the beginning of winter. During this time the stem gradually becomes woody.

In the flood basin of the Ili River this midge lives mainly in dense riparian thickets of polyramous tamarisk and on seedlings on flood basin salt marshes which are inundated by the spring floods. It is encountered much less frequently on tamarisks on the higher salt marshes and on the sand hills of the flood basin.

This midge is widely distributed in the basin of the Ili, where the polyramous tamarisk occurs. Its overall numbers are insignificant here, but there is a noticeable increase in places that are more favorable to its development.

The toothed-claw gall midge is infested by the following three species of parasite: Eupelmella vesicularis Retz., Eutelus sp. and Platygaster sp. It has been shown by examination of a great many galls that Eupelmella vesicularis Retz. and Eutelus sp. are encountered most frequently. The larvae of all three species live on the body of the midge larva. In 1953 40.3% and in 1954 55% of the second generation gall midges perished along the middle Ili as a result of the

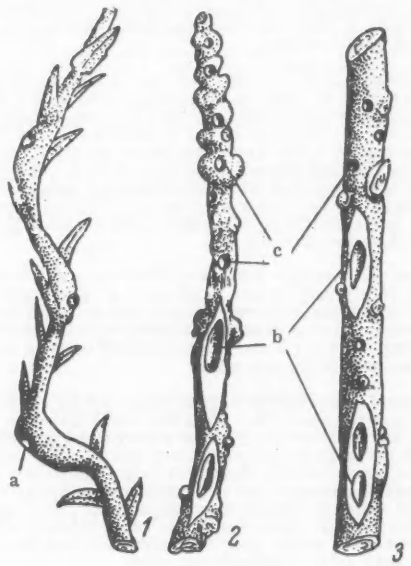

Fig. 3 - Tamarisk twigs damaged by the toothed-claw gall midge (Isosandalum dentipes Marik.). 1 - galls on green twig; 2 - upper part of fine woody twig; 3 - center section of 2. a and c - flight passages; b - larval chambers.

activity of these parasites (near Iliyskoye).

Where the numbers of toothed-claw midges are low they do not cause noticeable damage, but this is not true when they are present in considerable numbers. Infestation of green sprigs by the first generation gall midge leads almost invariably to their drying out, and subsequent snapping at the sites of the galls. This has a marked effect on seedlings, which may be entirely deprived of green foliage if they are heavily infested: this lowers the annual growth increment. The second generation gall midge causes the apices of the plant stems to dry out.

Mityayev's Gall Midge - Isosandalum Mitjaevi Marik.

This gall midge is morphologically similar to the bearded gall midge. The larvae of both species are found together on sprigs of polyramous tamarisk and do not cause gall formation. The midges fly at the end of May. It may be a symbiont of the toothed-claw gall midge. Found in the middle reaches of the Ili River near Iliyskoye.

The Tamarisk Gall Midge - Dasyneuriola Tamariciphila Marik.

Like the previous species, the tamarisk gall midge lives in the woody and green twigs of the polyramous tamarisk. Third generation larvae (there are three generations a year) winter inside woody twigs with a diameter of 4-10 mm, where they are concentrated in the central section. The larval chambers are isolated and longitudinal.

The third generation midges fly at the beginning of May, for 4-5 days. The females rest on the tamarisk branches and most of the males on the ground, where their size and coloration, which almost merges with that of the soil, make them very difficult to see. From time to time the males swarm round the apices of the tamarisk shrubs, where the females are to be found. Swarming lasts for 2-3 minutes, during which time some of the males seek out females and mate. After copulation the males return to the ground. Swarming is repeated every 15-20 minutes for 3-4 hours. Pairing is repeated.

The eggs are laid in the leaf axils of green sprigs. On hatching the larva penetrates the surface layer of the green sprig where it gives rise to a gall in the form of a scarcely discernible one-sided elongated swelling. The larvae pupate in the galls at about 20 May. The first generation midges fly between 20 and 25 May.

The development of the second generation, which also takes place on the green sprigs, lasts for approximately 20 days and the midges fly between 10 and 15 June. The females of this generation lay their eggs not on the green twigs but on fine woody stems, especially in the central sectors. The larvae penetrate beneath the bark and into the stem wood where they feed and grow until winter. The tamarisk gall midge is found wherever there is polyramous tamarisk in the basin of the Ili River. The numbers of the midge in this district are insignificant and they cause little damage.

The Flower Gall Midge - Dasyneura Sp.

The flower gall midge develops on the flowers of all the species of tamarisk growing in the Ili River basin. There are several generations a year. Nothing is known about wintering of this species. The minute whitish-pink larvae can always be found in the ovaries of polyramous tamarisk flowers when they bloom in the spring. In the course of the summer there are several generations of the midge on the flowers of polyramous, graceful and turnip-shaped tamarisks. When the hispid tamarisk flowers in the fall the midge transfers to it and apparently manages to develop through several further generations before winter begins. Despite the fact that there are several generations of flower gall midges a year their numbers are very small and they cause almost no damage to tamarisks. No parasites have as yet been discovered. The midge may be kept in check by the tamarisk fruit weevil, which also develops in the ovaries of tamarisk flowers and is found in large numbers in these localities.

The following two species have not been traced through to the adult stage and identified.

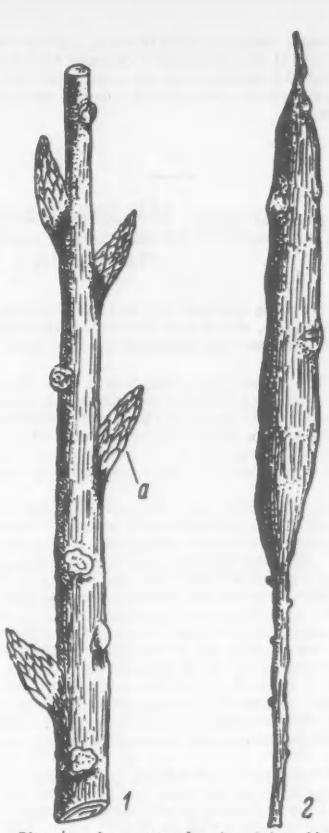

Fig. 4 - 1 - part of twig with galls (a) of bud gall midge (Itonididae gen. sp.); 2 - gall of stem gall midge (Itonididae gen. sp.).

The Bud Gall Midge (Itonididae, gen., sp.) (Fig. 4, 1)

A bud-shaped gall consisting of a great many closely adjacent scales on woody twigs. The gall is 4.5-6.0 mm long and 1.5-2.0 mm in diameter. It contains an elongated cavity in which the larva lives.

The gall midge was discovered in the flood plain of the upper Ili River. Wintering occurs in the larval stage in the gall. The midges apparently fly in the spring when the tamarisk buds in which they lay their eggs swell. The larva remains in the bud where it feeds and grows for the rest of the spring, all the summer and part of the autumn. The buds undergo quite noticeable changes during this time. Their fleshy and succulent green scales gradually become lighter in color and thinner and dry out entirely by the end of the summer, when they are straw yellow. The bud apex, which was blunt, becomes pointed.

This gall midge infests the polyramous, graceful and turnip-shaped tamarisks. The plants are not heavily infested, since the numbers of the midge are very small. Nevertheless some branches are thickly covered with galls. Such branches usually die in the autumn.

The Stem Gall Midge (Itonididae, gen., sp.) (Fig. 4, 2)

The gall is an elongated excrescence on a thin woody twig, 2.0-10.0 cm long and 0.3-0.5 cm in diameter. It is multi-chambered and has an uneven rugulose surface.

This midge was discovered in the upper and middle reaches of the Ili River. The larvae winter in the gall, which develops in the second half of the year. Small rose-colored larvae are to be found within them in elongated chambers at this time. The larvae attain their maximum size by the end of the fall and winter in the gall. The species,

which is numerous, damages polyramous, turnip-shaped and graceful tamarisk; it does extensive damage to polyramous tamarisk. Infested branches dry out soon after the flight of the midges and the plants are clearly greatly weakened when infestation is heavy.

Nine species of gall midge, the majority of which are new, have been discovered on the tamarisks of southeastern Kazakhstan.

The most injurious species of practical significance is the noxious gall midge, which has periodic outbreaks of mass breeding when it does serious damage to some species of tamarisk.

These outbreaks of mass breeding occurred at different times in different parts of the district where we were working and were largely dependent on the limiting activity of various species of parasites. It is therefore possible that the damage could be reduced by introducing galls that contain only parasites to a district where an outbreak of mass breeding is imminent from one in which it has declined.

We only encountered small numbers of the remaining species of gall midges during our investigations and they are not of practical significance as pests.

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THE BIOLOGICAL ISOLATION OF SUBSPECIES OF CULEX PIPIENS L. (DIPTERA, CULICIDAE)

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The Culex pipiens complex has always attracted the attention of investigators. Owing to its wide distribution, embracing the greater part of the globe, and to its complex intraspecific structure and great epidemiological significance, the group is of interest to biologists who are generally interested in the problems of species and speciation as well as to taxonomists, ecologists and epidemiologists. It was not accidental, therefore, that the meetings of a special section of the 1952 9th International Congress of Entomologists were devoted to C. pipiens and that an international commission was set up to promote further consistent study of the mosquitoes of this group throughout their area.

The subspecies in the complex (Culex pipiens pipiens L., C. pipiens molestus Forsk. and C. pipiens fatigans (Wiedemann) have now been quite well studied in relation to their morphology and their biology (Marshall and Staley, 1937; Jobling, 1938; Christophers, 1951; Knight, 1951; Mattingly et al., 1951; Rozeboom, 1951; Shute, 1951; Knight, 1953; Mattingly, 1953).

C. pipiens fatigans is morphologically clearly distinct from C. pipiens pipiens and C. pipiens molestus in the structure of the male genital apparatus and in the siphon of the larvae. On the other hand the morphological attributes that distinguish C. pipiens pipiens and C. pipiens molestus from each other are incomparably less than the biological attributes, as can be seen clearly from Table 1.

In biological features C. pipiens fatigans is similar to C. pipiens molestus (stenogamous and homodynamic and differs only in not being autogenous.

This group, which is one of the most widespread groups of mosquitoes, is found between latitude 60° N. and latitude 40° S. (Mattingly et al., 1951; Horsfall, 1955). C. pipiens pipiens is mainly a Holarctic form with isolated populations in certain parts of Africa, while C. pipiens fatigans is a tropical and subtropical form.

The distribution areas of these subspecies now present quite a clear picture, but the same cannot be said of C. pipiens molestus. This is mainly due to the difficulty of differentiating between C. pipiens pipiens and C. pipiens molestus (which often coexist) from purely morphological attributes. C. pipiens molestus, although tropical in origin (Northeast Africa, Palestine), is now very widespread in other climatic belts and is encountered in North and South America, East Africa and Australia. A typical feature of this complex is the partial overlapping of the distribution areas of the various subspecies, from which it naturally follows that there may be natural hybrids in given sectors of the area. In actual fact the populations of what was known as C. pipiens pallens Coq. (= C. comitatus D. and C. dipseticus D.) found in the Far East (the Pacific seaboard to the south of Japan) and in North America (California) turned out to be merely populations of natural hybrids between C. pipiens pipiens and C. pipiens fatigans (Sundararaman, 1949; Yamaguti and La Casse, 1951; Rozeboom, 1951; Mattingly, 1953).

The possibility of hybridization has also been confirmed experimentally (Farid, 1949). C. pipiens molestus and C. pipiens fatigans cross freely under both natural (Mattingly, 1956) and laboratory conditions (Weyer, 1935-1936; Callot, 1955; Mattingly, 1956; Rozeboom, 1958). C. pipiens pipiens has also been repeatedly crossed with C. pipiens molestus under experimental conditions (Weyer, 1935-1936; Tate and Vincent, 1936; Knight, 1951). A quite complete treatment of the genetic aspect of hybridization within C. pipiens has been given in the recent summary by Rozeboom and Kitzmiller (1958).

However, the prolonged independent existence of intraspecific hybrid populations that develop under natural conditions is dependent both on the capacity of the subspecies to cross and give rise to fertile progeny and on the degree of correspondence between the life cycle of the resultant hybrids and surrounding climatic conditions.

Of the three subspecies only one, C. pipiens pipiens, has a special seasonal physiological adaptation — the imaginal diapause. Imaginal diapause is totally lacking in C. pipiens molestus and C. pipiens fatigans, owing to their southerly origin. Thus the fate of hybrids resulting from the crossing of homodynamic and heterodynamic forms in temperate climatic zones is to a large extent dependent on the nature of inheritance of the imaginal diapause. The level of biological isolation of the subspecies is also associated with the possibility of the prolonged survival of hybrids under natural conditions. It must be stressed that with very slight morphological differences these subspecies attain such a high degree of biological adaptation that some authors are inclined to treat them as separate species.

All that has been said stresses the need for attentive study of the nature of the inheritance of imaginal diapause when homodynamic and heterodynamic forms of mosquitoes are crossed. The subject of our investigations was: a comparative study of the inheritance of certain physiological and morphological features when C. pipiens pipiens and C. pipiens molestus were cross-bred under experimental conditions and the use of the data thus obtained to analyze the natural relationships between these subspecies. This question has not received any detailed treatment in the literature, since the majority of works on hybridization within C. pipiens deal with the inheritance of such exclusively morphological characteristics as the size of the larval siphonal index (Callot, 1947) and the structure of the male genitalia (Weyer, 1936; Sundararaman, 1949; Barr and Kartmann, 1951), while the only physiological features to be dealt with are the inheritance of stenogamy and autogeny (Tate and Vincent, 1936; Spielman, 1957).

Procedure and Material

The whole developmental cycle of the mosquitoes took place in thermostatic chambers, temperature and light being controlled. The varying length of day was adjusted automatically or by manual setting. The light source was an electric lamp. In some cases the required length of day was obtained by combining daylight and electric illumination.

Mosquitoes reared with a long day at 23-24°C were used for the first (F_1) cross. Separation of males and females was effected at the pupal stage, from the structure of the 10th abdominal segment (Moorfield, 1951; Carpenter, 1952). For hybridization 20 males and 20 females were placed in muslin rearing boxes (30 x 20 x 15 cm).

The larvae were reared in enamel vessels and fed with an emulsion of ground dried daphnia. The mosquitoes were kept in muslin rearing boxes (30 x 20 x 15 cm). On the day of emergence from the pupae the mosquitoes were given sugar syrup, after which they fed on man. Females were dissected after digestion of blood and the state of the fat body and the developmental stages of the ovaries were considered in relation to the accounts of Christophers (1911) and Mer (1936).

Table 1

Basic morphological and biological distinctions between C. pipiens pipiens and C. pipiens molestus

	C. pipiens pipiens	C. pipiens molestus
Egg	Site of micropylar apparatus with marked latticed zone. Egg mass in a raft.	Site of micropylar apparatus with latticed zone poorly defined. Form of egg masses very diverse.
Larva	Siphonal index approx. 5. Siphonal clusters have less branches on average.	Siphonal index approx. 3-4. Siphonal clusters have more branches on average.
Imago	Darker color. Total length of first 4 segments of maxillary palps in male exceeds the length of the proboscis including the labellum. Intake of blood is essential to egg formation. Does not copulate in small live boxes (eurygamous). Has imaginal diapause (heterodynamism).	Lighter color. Total length of 4 first segments of palps does not exceed the length of the proboscis including the labellum. First egg mass develops without intake of blood (autogeny). A large room is sufficient for copulation (stenogamous). No imaginal diapause (homodynamism).

Females whose ovaries had not developed beyond Christophers' second stage after final digestion of the blood were treated as diapausing. In dissection we only took into account those insects that had had a good blood meal, so as to exclude the possibility that absence of maturation might be due to an insufficient volume of blood having been taken (Detinova, 1953).

The size of the siphonal index, i.e., the ratio of the length of the siphon to its width, was used as a morphological characteristic of the larvae. Permanent mounts were prepared from the larval integuments of 4th-stage larvae (Volyanskaya, 1957). The measurements were made by standard methods (Monchadskiy, 1951) with an ocular micrometer.

The following live material was used in the experiments: laboratory cultures of C. pipiens molestus from Leningrad, Moscow and Czechoslovakia (Gotwaldov); a culture of the Baku form of C. pipiens molestus produced by us from several natural populations discovered within the boundaries of Baku; the Leningrad form of C. pipiens pipiens obtained in some cases from pupae and egg rafts collected wild and in other cases from egg rafts laid by reactivated wintering females.

Physiological Attributes of Culex Pipiens L., C. Pipiens Molestus Forsk. and Their Hybrid Forms

The onset of imaginal diapause in blood-sucking mosquitoes is determined by seasonal shortening in the length of the day (Danilevskiy and Glinyanaya, 1958; Vinogradova, 1958). In our experiments we studied both the inheritance of the imaginal diapause when the homodynamic C. pipiens molestus was crossed with the heterodynamic C. pipiens pipiens and the inheritance of the ecological mechanism which regulates its onset — the photoperiodic reaction.

Before proceeding to an examination of photoperiodism in hybrids we must first deal briefly with the photoperiodic reaction in the parental forms.

The Leningrad population of C. pipiens pipiens has a clearly defined photoperiodic reaction (see the diagram). The number of diapausing individuals increases as the length of the day shortens. The fairly high photoperiodic threshhold is a general distinctive feature of all northern populations.

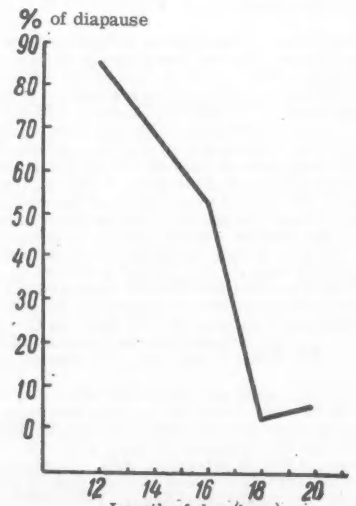
C. pipiens molestus behaves differently. It is a native of the tropics that is also widely distributed in the temperate zone, where its existence is not secured by the elaboration of physiological adaptations of the type of the diapause, as in C. pipiens pipiens, but by adaptation to existence in a very specific ecological niche: C. pipiens molestus is becoming an exclusively synanthropic form, which develops throughout the year in cellars and other underground constructions in towns. Since C. pipiens molestus has no diapause it also has no photoperiodic reaction.

In confirmation one can cite data on the effect of photoperiodic conditions on the maturing of C. pipiens molestus females, although these data relate to the Baku and not the Leningrad form (Table 2).

Table 2

Influence of photoperiodic conditions of development on the maturing of C. pipiens molestus females (Baku)

Length of day (hrs)	Mean temperature, °C.	Number of blood-sucking females	% of females maturing
16	24.1	62	100
12	24.1	30	100



Dependence of the onset of diapause in Culex pipiens on light conditions for their development.

Table 3

Photoperiodic reaction of F_1 and F_2 hybrids at a temperature of 22-23°C (♀♀ C. pipiens molestus X ♂♂ C. pipiens pipiens)

Generation	Length of day (hrs)	No. of females fed with blood	Of which there matured	
			Number	%
F_1	20	78	78	100
	14	5	5	100
	12	29	29	100
F_2	20	41	41	100
	16	25	23	92
	15, 14	24	21	87.5
	12	39	30	76.8

It can be seen from the Table that all the mosquitoes mature both when the day is short and when it is long.

Reciprocal crosses were made between C. pipiens pipiens and C. pipiens molestus to study the photoperiodic reaction of hybrids. Viable progeny were only obtained from one-sided crossing — C. pipiens molestus females with C. pipiens pipiens males. Mating was observed in the opposite combinations, but no larvae emerged from the eggs. There is a previous mention in the literature (Callot, 1947) of the difficulty of obtaining hybrids between C. pipiens pipiens females and C. pipiens molestus males. All the larvae of the first hybrid generation were obtained from autogenous egg rafts, while the second generation was obtained from eggs laid after blood had been taken.

The total results of two repeated crossings of ♀♀ C. pipiens molestus and ♂♂ C. pipiens pipiens to demonstrate the manifestation of a photoperiodic reaction in the hybrid generations are shown in Table 3.

It is clear from this Table that in the first hybrid generation (F_1) all the mosquitoes matured independently of the light conditions during their development, i.e., imaginal diapause was absent, as in the maternal form — C. pipiens molestus. In the second hybrid generation there was a definite segregation in physiological attributes. The majority of the hybrids matured in the same way as C. pipiens molestus, but in all photoperiodic conditions starting with 16 hrs. there was a small percentage of diapausing individuals. There were most diapausing insects (23.2%) when the day was typically short (12 hrs. of light). Thus the paternal attribute of imaginal diapause appeared in approximately 1/4 of the F_2 hybrids.

In this connection there are interesting data on the structure of the ovaries in hybrid females. There is a marked difference in the structure of the gonads in starving females of C. pipiens pipiens and C. pipiens molestus (Weyer, 1935-1936). C. pipiens molestus can lay the first egg raft without a blood meal. This means that the ovaries are more developed and richer in yolk in young females of this subspecies that have not had a blood meal; moreover the follicles of one ovary are normally at different stages of development and present a mosaic pattern. In C. pipiens pipiens females that have not taken blood the ovaries remain at the very earliest stages of development and have not progressed beyond Christophers' stage I-II or rarely stage II. The overwhelming majority of the follicles in a given individual are at the same stage of development. I have dissected 4-8 day F_2 females, that have only taken carbohydrate nourishment. It is clear from the dissection results in Table 4 that approximately 25% of the hybrids (34 females) are phenotypically akin to C. pipiens molestus, and that these include all individuals with "mosaic" ovaries and those with mature or maturing eggs (stages III, IV and V). The remainder of the F_2 hybrids are similar to C. pipiens pipiens in gonad structure.

Morphological Features of Culex Pipiens Pipiens L., C. Pipiens Molestus Forsk. and Hybrid Forms

Of all the main morphological differences between C. pipiens pipiens and C. pipiens molestus — coloration of the imago, length of the male maxillary palps, number of hairs in the siphonal clusters, size of the siphonal index — it was

Table 4

State of ovaries in F_2 females that had only received carbohydrate nourishment (♀♀ C. pipiens molestus X ♂♂ C. pipiens pipiens)

	Follicles at one stage of development					Follicles at different stages of development	
	I, I–II	Beginning of II	End of II	III	IV, V	I & II	II & III
Number of females	73	22	5	2	12	14	6
Percentage.....	54.5	16.4	3.7	1.5	9	10.4	4.5

Table 5

Siphonal index of parental and hybrid generations (♂♂ C. pipiens pipiens X ♀♀ C. pipiens molestus

Form	Origin of material	Number of measurements	Mean value of siphonal index plus mean error $M \pm m$	Coefficient of variation V (as a %)
C. pipiens pipiens, Father	Old Peterhof.....	118	5.04 ± 0.034	7.3
C. pipiens molestus,	Leningrad.....	109	4.16 ± 0.042	10.6
F_1 hybrids.....		73	4.77 ± 0.035	6.3
F_2 hybrids.....		138	4.37 ± 0.041	11.1

Table 6

Morphological features of egg masses laid by first and second hybrid generations

Generations	Type of egg mass			Number of egg masses examined
	C. pipiens pipiens	*C. pipiens molestus*	Single eggs	
F_1, laying after blood meal	29	2	—	31
F_2, laying after blood meal	5	32	3	40
F_2, autogenous laying	4	25	3	32

the last that was selected as the main criterion for the analysis of hybrid generations. Comparative results of the measurement of the index in the parental and hybrid forms are given in Table 5.[1] There is a difference in the size of the index in the parental forms (considerably larger in C. pipiens pipiens); in both hybrid generations the siphonal index is intermediate between that of the parents, being more akin to that of C pipiens pipiens in the first generation and to that of C. pipiens molestus in the second. Similar features in the morphology of hybrids have been noted in the literature (Callot, 1947).

The type of egg mass was studied as an additional morphological attribute (Table 6). In the first hybrid generation the egg masses are mainly of the C. pipiens pipiens type, but in the second they are mainly of the C. pipiens molestus type. This holds both for egg masses laid as a result of blood feeding and for those laid in an autogenous manner.

All that has been said about the physiological and morphological features of hybrids can be summarized as follows.

When C. pipiens molestus females are crossed with C. pipiens pipiens males an attribute such as imaginal diapause is recessive in the first hybrid generation; a definite segregation commences in the second hybrid generation and imaginal diapause appears in some individuals. One morphological attribute, the size of the siphonal index, is midway between that for C. pipiens pipiens and C. pipiens molestus in the F_1 and F_2 hybrids.

[1] These data were processed by the normal formulae in variational statistics.

Hybridization of the Geographic Forms of Culex Pipiens Molestus

The present state of our knowledge on hybridization between different subspecies of the C. pipiens group and separate geographic populations within the framework of a subspecies has been fully dealt with in the last summary by Rozeboom and Kitzmiller (1958). It is interesting to note that there are considerable genetic differences between separate geographic populations of C. pipiens molestus, in the varying degree and different forms of genetic isolation between them. Laven (1951) has suggested from an examination of a great deal of experimental material that there are at least 8-10 population groups in C. pipiens molestus, that differ in their capacity to mate and give rise to progeny. Kitzmiller (1951) suggests that since C. pipiens molestus is a highly evolving form, genetic changes are not as yet accompanied by physiological and morphological changes. There is, in fact, comparatively little difference in a morphological attribute such as the siphonal index in the different geographic populations (Table 7)

Table 7

Siphonal index of European forms of C. pipiens molestus

Origin of material	Siphonal index	Number of measurements	Author
Hungary (Budapest)	3.8	10	Mihalyi, Zoltai, 1956.
Hungary (Matraverebili)	4.1	10	
Hungary (Tikani)	3.9	25	
Britain (Hants, Hayling Island)	4.0	155	Marshall, 1938.
Britain (Worcs, Hull)	4.2	74	
Britain (London)	4.0	50	
France (Paris)	4.3	112	
Greece	3.9	119	
Malta	3.8	100	
Czechoslovakia (Gotwaldov)	3.9	73	Our data.

Table 8

Results of crossing geographic forms of C. pipiens molestus (+ denotes variants giving rise to viable hybrids; gaps indicate that these combinations were not studied)

♂♂ \ ♀♀	Leningrad	Moscow	Gotwaldov	Baku
Leningrad	+	+	+	+
Moscow	+	+	+	
Gotwaldov	+	+	+	+
Baku	+		+	+

The existence of certain genetic groups has also been postulated in relation to another subspecies — C. pipiens fatigans (Roubaud, 1956).

We crossed several geographic forms of C. pipiens molestus (Table 8) from central and eastern Europe in order to establish their genetic affinity.

Despite the considerable geographic separation of the populations being studied, no genetic barrier could be detected between them: crossing took place in all the variants and the resultant hybrids were viable and developed normally.

Analysis of Natural Populations of Culex Pipiens L.

Study of the inheritance of physiological and morphological attributes in hybridization under laboratory conditions makes it possible to throw light on some aspects of the relations between subspecies under natural conditions. One can only get a really complete picture of the possible forms of the interrelations of subspecies within the C. pipiens group by analyzing natural populations in several climatically diverse sectors of the distribution area. Our experiments can serve as a representation of the interrelations between C. pipiens pipiens and C. pipiens molestus in the northern part of the area. It should be noted that the experimental results do not give a complete picture, since only one-sided crossing of C. pipiens molestus females with C. pipiens pipiens males was achieved. Nevertheless, the difficulty of obtaining a reciprocal cross in the laboratory indicates how rarely this phenomenon is likely to be encountered in nature: the percentage of such hybrids in nature is probably, therefore, quite insignificant. If the first hybrid generation appears in the autumn (as seems most likely, since the mass appearance of C. pipiens pipiens in the north of its area is in the second half of the summer), it will be totally eliminated during the winter, owing to the absence of imaginal diapause; only the very few individuals of the second hybrid generation that have inherited the diapause from the paternal form may survive the winter. Thus the absence of the diapause in the hybrids makes it impossible for them to survive for long and reproduce themselves in nature and thus ensures the biological isolation of the parental forms.

In this connection it is of interest to deal briefly with the very similar statement of the problem in the work of McMillan (1958), who analyzed the seasonal correlations between North American populations of C. pipiens pipiens and C. pipiens fatigans in those parts of the area where they coexist. Using the size of the genital index (DV/D) as a criterion he established that in spring and early summer the typical C. pipiens pipiens predominates, that there is a subsequent tendency for the appearance of intermediate forms and that in the course of the summer the intermediate forms tend progressively towards C. pipiens fatigans in the DV/D ratio, which is an indication of continual hybridization in nature; in the following spring it is once again exclusively C. pipiens pipiens that is encountered. We still do not know the laws of inheritance of the diapause in the hybridization of C. pipiens pipiens and C. pipiens fatigans, but one can assume by analogy with our experimental data, that inability to survive the winter will be decisive in the elimination of these hybrid forms. It is thought that the absence of imaginal diapause is the main factor that limits the spread of C. pipiens fatigans to the north.

In the southern part of the area the relationships between C. pipiens pipiens and C. pipiens molestus may be somewhat different. This follows from an analysis of the morpho-biological features of several natural populations of C. pipiens in Azerbaydzhan (40-41°N.). A combination of such biological attributes as autogeny, the capacity to mate in small rearing boxes, activity of feeding on man, existence of a photoperiodic reaction and the morphological attribute of the size of the siphonal index were used to establish identity of a subspecies. The first generations of a laboratory culture obtained from natural egg masses or larvae were analyzed. The live material was drawn from urban conditions (Baku) and from a village location (Yevlakh, Khersonovka). The results are presented in Table 9, where certain typical forms from other parts of the area are compared with the Azerbaydzhanian forms of C. pipiens. It can be seen from this Table that the differences in the size of the siphonal index are greatly levelled in the Azerbaydzhanian C. pipiens pipiens and C. pipiens molestus. Both subspecies are so close to each other in this morphological attribute that in the absence of a biological description of the separate populations it would be difficult to establish the subspecies with certainty. One possible explanation for this intermediacy in the morphological attributes of some populations is that they could be of hybrid origin. The very mild climate of these latitudes is favorable to the development and existence of natural hybrids. Diagnosis of such hybrid populations is, however, very complicated, since biologically they may be very closely reminiscent of C. pipiens molestus: autogeny and stenogamy are already present to a certain extent in the first hybrid generation. There are isolated indications in the literature that mixed hybrid populations of C. pipiens may exist in nature: Rossi-Espagnet (1957) notes this for Italy (in the province of Latina — 41-43°N.) and it has also been noted by Vincent (1933) for Hungary and by Sicart (1958) for France and Tunis.

Certain physiological features of the southern forms of C. pipiens should also be noted. We studied the photoperiodic reaction of C. pipiens pipiens from Yevlakh (Azerbaydzhan): the findings are given in Table 10.

There is a small percentage of non-matured females in all photoperiodic conditions. No relationship could, however, be detected between the diapause and the length of day. When the experiment was conducted at 23.8°C with a typically short day (12 hrs. of light) the diapause was absent for all practical purposes. The possibility is not exclused that the influence of the light factor would be stronger if the temperature level were to be lower.

Table 9

Siphonal index of C. pipiens pipiens and C. pipiens molestus

Subspecies	Origin of material	Number of measurements	Mean value of siphonal index plus mean error M ± m	Coefficient variation V (as a %)
C. pipiens pipiens.	Old Peterhof	118	5.04 ± 0.034	7.3
C. pipiens pipiens?	Azerbaydzhan (Khersonovka)	102	4.94 ± 0.046	9.4
C. pipiens pipiens.	Azerbaydzhan (Yevlakh)	121	4.74 ± 0.034	8
C. pipiens molestus.	Baku (factory 1)	107	4.61 ± 0.044	10
The same	Baku (hospital)	119	4.33 ± 0.048	12.1
The same	Baku (factory 2)	118	3.68 ± 0.042	12.6
The same	Baku (culture)	118	3.98 ± 0.036	9.9
The same	Czechoslovakia, Gotwaldov (culture)	73	3.89 ± 0.043	9.6
The same	Moscow, (culture)	65	4.07 ± 0.045	9.8
The same	Leningrad (culture)	109	4.16 ± 0.042	10.6

Table 10

Photoperiodic reaction of C. pipiens pipiens from Yevlakh (Azerbaydzhan) at a temperature of 23.8°C

Length of day (hrs)	Number of blood-fed females	Of which there matured	
		Number	%
16	17	1	5.8
14	26	3	11.5
12	52	6	11.5

Nevertheless, the very fact that photoperiodism has such a slight effect on the physiological state of C. pipiens pipiens females of southern origin gives grounds for assuming that there can be considerable variation in the degree of expression of imaginal diapause in this subspecies within its distribution area. Unlike the northern forms of C. pipiens pipiens, which have a marked diapause, the southern forms, which experience a mild winter, probably only retain a slight tendency to form a diapause or lose it altogether. Thus C. pipiens pipiens and C. pipiens molestus are physiologically extremely similar.

The attempt to analyze natural populations of C. pipiens using experimental data on the inheritance of various physiological and morphological features has thus shown that the possible forms in the natural interrelations between the two subspecies are very complex, are controlled by many factors and probably differ markedly in different parts of their area.

CONCLUSIONS

1. C. pipiens pipiens is primarily palearctic in distribution and has imaginal diapause, the onset of which is regulated by seasonal shortening in the length of the day. Under experimental conditions the diapause commences in the majority of individuals of the northern form (Leningrad) when the day is approximately 12 hrs.

2. C. pipiens molestus, which comes from the tropical regions, is now widely distributed in temperate zones as well, where its existence is secured by adaptation to life in a specific ecological niche: C. pipiens molestus is becoming an exclusively synanthropic species that develops throughout the year without diapause.

3. Owing to the absence of any genetic barrier between these subspecies in regions where their distribution areas overlap, hybrid forms may develop, but their survival will depend on the extent to which their seasonal cycle matches surrounding conditions.

4. When C. pipiens molestus females are crossed with C. pipiens pipiens males under experimental conditions, imaginal diapause is absent from the first hybrid generation and only present in a part (25%) of the individuals of the second hybrid generation. The morphological attributes of the hybrids (siphonal index) are midway between those of the parental forms.

5. In a temperate climate with a cold winter the nature of the inheritance of imaginal diapause probably excludes the possibility that hybrid forms can survive in nature and thus ensures a high degree of biological isolation of the two subspecies.

Analysis of natural populations of C. pipiens in Azerbaydzhan shows that the differences between subspecies are largely evened out in the southern part of the area, where the winter is warm: both subspecies can probably give rise to natural hybrid populations.

Thus the degree of biological isolation of C. pipiens pipiens and C. pipiens molestus varies in different sectors of the distribution area.

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BIOLOGICAL PRINCIPLES OF THE CONTROL OF WARBLE-FLIES

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Warble-flies cause considerable harm to animal husbandry. It has been estimated that warble flies cause losses of the order of 450,000 rubles annually to cattle alone in the Soviet Union, 90% of this sum being losses of milk and meat (Breyev and Grunin, 1959). Losses due to warble-fly in the reindeer amount to 30% of the income from reindeer husbandry (Breyev and Savel'yev, 1958). Considerable losses are caused by other warble-flies, especially sheep nasal fly, which is sometimes responsible for extensive epizootics in the animals (Gan, 1953). Gastrophylosis and warble-fly infections of the nasal membrane also do great damage to horses. The productivity of animal husbandry would be greatly increased if these losses could be reduced as far as possible or, ideally, entirely eliminated.

In considering the factors that make for success in the control of warble-flies, or any other insect pest, it has to be stressed that success is as much due to a knowledge of the biological and ecological features of the species as to organizational and economic factors. Generally speaking, any campaign is an operation against a harmful natural factor, the success of which depends on knowing on what, with what and how one must operate and who must operate and under what conditions to secure the maximum effect at the right time.

Insufficient attention is, unfortunately, often paid to the organizational side of the measures being undertaken, although it is no less important and often no less complicated than a study of the biology of the pest in the broadest sense of the word study. If we are to succeed in preventing the development of a harmful species and reduce its numbers to the minimum our organizational measures must be on a level with its adaptation to the conditions of its existence, which has been developed in the course of evolution and which governs its numbers. Bad organization in insect control is due to the fact that this branch of production is fairly poorly developed in the Soviet Union and has still not become a subject in its own right, even though man is constantly coming up against pests in the course of his practical activity since the insect kingdom is so diverse, and even though entomology has been in existence as a science for more than 200 years.

It is not the object of the present article to deal with the organizational aspects of warble-fly control. Our intention is to consider the biological aspect of the problem in the light of modern knowledge. It should, however, be noted that there is a direct link between the biological and the organizational and economic sides of the question. Other conditions being equal, the ease with which the destruction of pests can be organized will be directly dependent on the cheapness and effectiveness of the method employed and on the labor time involved. These factors, in their turn, are dependent on the means at our disposal and, especially, on the ability to discover the periods in the life cycle of the pest at which these measures will do the most damage. This is already a purely biological problem and one which we intend to consider in relation to warble-flies.

It is natural in any study of the biological foundations for the control of a harmful species to ask oneself why it is harmful. What is the biological basis for the economic concept of harm? The damage done by warble-flies is connected with the fact that their grubs are parasitic on the connective tissue of animals and thus harm the organism as a whole in various ways and also with the fact that the harmful species are quite numerous. It is self-evident that the amount of damage caused by the majority of insect pests (especially plant pests) is mainly due to the large numbers of the harmful species. From the biological point of view, therefore, the problem of insect control is largely one of restricting the numbers of harmful species.

If destructive measures are to have the maximum effect it is important to establish when they should be carried out, as has already been mentioned, i.e., to find the periods in the life cycle when they will do most damage. From this point of view we need to consider both the factors that determine the relative size and fluctuation of the warble-fly population in a given territory and questions concerned with the development and specific features of warble-fly parasitism in the connective tissue of animals.

Origin and Specific Features of the Parasitism of 1st-Stage Warble-Fly Larvae and Control Measures

It is a general biological feature of all the warble-flies (the Hypodermatidae) that the 2nd- and 3rd-stage larvae live in subcutaneous connective capsules in ungulates and rodents: Oedemagena, Hypoderma, Crivellia, Przhevalskiana, Pallasiomyia and Pavlovskiata are parasitic on ungulates and Oestromyia and Portschinskia on rodents.

The fully grown larvae emerge from the capsules, fall to the ground and pupate in the surface layers of the soil. The larvae of the warble-flies of ungulates winter as do the pupae of the warble flies of rodents. The adult insects emerge with their sexual products already developed and after mating the females seek out the host animals and lay their eggs on their hairs.

Recent data (Grunin, 1950) show that the origin of warble-flies is associated with the transition to parasitism of certain Diptera biologically associated with mammals (coprophages and species living in wounds), as is observed at the present time in Cordylobia and Wohlfahrtia. Grunin considers it likely that there was independent transition to parasitism on various groups of mammals by species that were closely related in the classification, possibly species of one genus, which originated the separate groups of warble-flies: group one — the Oedemagena, Hypoderma and related genera, group two — Portschinskia, group three — Oestromyia.

Feeding and growth in warble-flies is most active in the 2nd- and 3rd-stage larvae, i.e., during life in capsules of subcutaneous connective tissue. The larva brings in its food supply, the blood and lymph of the host animal, by continual stimulation of the walls of the capsule by the numerous spinules on its cuticle. Respiration is effected and excrement removed via a fistula in the skin of the host at the posterior end of the larva.

Living conditions in the capsules (plentiful supply of rich food, constant temperature, good protection from all sorts of harmful external influences) are especially favorable to warble-fly larvae. It is at this period that the main energy resources both for the development of the larvae and for the whole future life of the insect are accumulated (adult warble-flies do not feed). The insects are also highly fertile — there are from 500 to 700 eggs in each female. The weight increase during life in the capsule is approximately 92-96% of the weight of the mature larva before pupation. Thus, the 1st-stage larva of Oedemagena weighs

approximately 65 mg[1] at moulting, while the 3rd-stage larva weights 1600 mg at pupation: the corresponding figures for Hypoderma bovis De Geer are approximately 120 mg[1] and 1500 mg.

But the formation of a capsule of connective tissue is a normal defensive reaction of an animal to the introduction of any foreign body. It can be said that, in adapting themselves to life in such capsules, warble-flies have been able to utilize this reaction as a condition for their existence. The formation of the fistula clearly plays a considerable part in adaptation to encapsulation. The direct access of atmospheric oxygen to the trachea clearly increases the metabolic rate, thus enabling the plentiful food supply to be utilized to the full. The poisonous waste products of metabolism are discharged through the same fistula. This prevents contamination of the liquid medium within the capsule, which would not affect the larva but might be toxic to the host.

Since the physiology of warble-fly larvae has not been studied in sufficient detail, one can only assess the increase in the metabolic rate in 2nd- and 3rd-stage larvae by comparison with the 1st-stage larvae from oblique data, such as the daily weight increment. If one knows the weight of a 1st-stage larva on eclosion and before moulting, the weight of a 3rd-stage larva on pupation and the mean duration of the development of all stages it is not difficult to calculate the increment. In H. bovis it is approx. 0.5 mg/24 hr in 1st-stage larvae and approx. 20 mg/24 hr in 2nd- and 3rd-stage larvae. The corresponding figures for O. tarandi larvae are 0.7 and 7.0 mg/24 hr.

The importance of the fistula for the normal life of encapsulated larvae is shown by the fact that the larvae perish if the fistula is long sealed by scabs of dried puss. Such occurrences are, however, comparatively rare and pustulation does not normally occur in the capsules. Karchevskaya and Kasatkevich (1934) have shown that the contents of the capsules are normally sterile, despite their direct connection with the external environment. It was later found that the intestine of H. bovis larvae contains a bacteriostatic agent that is active in relation to a number of Gram-positive bacteria, including streptococci and staphylococci (Jettmar, 1953). It is highly probable that in the biological sense as well, at least in the warble-flies of ungulates, the concentration of the fistular capsules containing larvae on the upper part of the body is to some extent related to the fact that the openings of the fistula are less contaminated under these conditions.

We have shown that warble-flies derive a number of biological advantages from life in capsules of connective tissue. But only the 2nd- and 3rd-stage larvae of the warble-flies parasitic on ungulates (the group which contains all the harmful species) live in these capsules. After emerging from the egg and boring through the hide the 1st-stage larva lives for a period, the duration of which varies with the species, in a migratory state in the connective tissue of the host: beneath the skin, between muscles and sometimes in an organ: Hypoderma lineata De Vill., for example, migrates in the connective tissue of the gullet. Oestromyia species, which are parasitic on rodents, are apparently an exception: the 1st-stage larvae do not migrate and the capsules are formed at the site where the larva initially bored through the skin. The biological differences between different species of warble-flies on ungulates are most apparent during this period and affect the length of development in the 1st-stage and the nature of the path followed in migration.

It is still difficult to say why migration follows a certain course and lasts for a certain time in different species of warble-flies. One can only assume that it is most probably not the length of the migration that determines the duration of the first larval stage, but that the distance traveled is determined by the time taken by the larva to prepare itself for life in the capsule, at which point moulting to the 2nd-stage larva occurs.

The first larval stage is an extremely critical period in the life cycle of warble-flies. Many of the larvae perish before they can penetrate beneath the skin. It has been shown (Breyev and Karazeyeva, 1952) that if the newly emerged larva of the reindeer warble-fly is not immediately able to penetrate beneath the skin, it cannot remain for long on the surface and will perish within an hour or even sooner. Similar facts are known in relation to H. bovis (Gebauer, 1958). Furthermore, the host organism combats the parasite most actively during migration. Some of the larvae are encapsulated by connective tissue and perish before the end of migration. A comparison of the number of larvae to emerge from eggs laid on reindeer with the number of live larvae at the end of migration has shown that, in some cases, only 5% of the larvae complete the migration (see the Table). Similar observations exist for H. bovis. Thus, Kurchikov (1951) found in the course of a morphopathological study of changes brought about in cattle by H. bovis larvae of all stages that the majority of the larvae perished during migration. According to Gebauer (1958) a large number of 1st-stage H. bovis larvae also perish during the formation of the fistula.

Survival of 1st-stage reindeer warble-fly larvae in the body of the reindeer (Malozemel'skaya tundra, 1951)

Experimental animal	Quantity of larvae to hatch from eggs deposited on the hairs of the reindeer	Quantity of 1st-stage larvae found in the body of the reindeer	Percentage of surviving 1st-stage larvae
Calf No. 1	338	195	57.9%
Calf No. 3	607	222	26.6
She-deer No. 1	723	39	5.4
She-deer No. 2	1387	422	30.4
	3055	878	28.7%

It may therefore be suggested that 1st-stage larvae, which are not suited to life encapsulated in connective tissue, cannot survive without migration, since a halt of sufficient duration to allow a capsule to be formed round them unavoidably causes death.

It is known that metabolic processes are greatly intensified in the tissues of an inflamed area and that this greatly increases oxygen uptake by the inflamed tissues (by 40-80%). But even this increased supply of oxygen does not suffice to complete all the oxidation processes and incompletely oxidized intermediate decay products accumulate at the focus of the inflammation (Pavlenko, 1948). It is possible that it is these conditions, and especially the oxygen deficit, that compel the larva to quite the centers of inflammation that it has created for itself. It is also possible that the accumulation of H. lineata larvae in the layer of connective tissue in the gullet and of H. bovis larvae in the membranes of the spinal cord is connected with the fact that inflammation develops slowly in these tissues and that the larvae are therefore able to remain in it for a relatively long period.

This view on the causes of larval migration has been confirmed by Orlov's recently published observations (1959) on the migration of 1st-stage H. lineata larvae in the gullet of cattle. Orlov established that the larvae halt at several points in the connective tissue layer of the gullet and that the distance between halts increases with the growth of the larva. Tissue inflammation is more marked at a point of halt than elsewehere and affects considerable areas. It is quite possible that large larvae cause greater inflammation by producing larger quantities of secretions and excretions and that this compels them to keep moving and to cover a greater distance on each occasion from the sites of inflammation that they have created. Orlov found that the larvae migrated farthest in the gullets of adult cattle, i.e., in cases in which one could assume that tissue reaction to the larvae would be most active.

Khan, Connell and Darcel (1960) found that 86% of 1st-stage H. bovis larvae were killed by subcutaneous or intramuscular injection of Dimethoate, by comparison with the control, whereas H. lineata larvae were not killed. They concluded that one reason for the slight effect of this drug on H. lineata could be that it failed to penetrate the less vascular tunica submucosa of the gullet in sufficient quantities. If, however, a tissue is less vascular inflammation should develop more slowly.

Full confirmation will, of course, have to await further

[1] The weight of the 1st-stage larva was calculated from its dimensions.

investigation. Nevertheless, it can already be stated that the observed differences in the extent to which reindeer are affected by the 3rd-stage larvae of O. tarandi in relation to the sex, age, health and level of nutrition of the host animals (Breyev and Karazeyeva, 1953) and cattle are affected by the 2nd- and 3rd-stage larvae of H. bovis and H. lineata in relation to the age and level of nutrition of the hosts (Blagoveshchenskiy and Pomerantsev, 1929; Blagoveshchenskiy and Pavlovskiy, 1930; Kurchikov, 1951; Lutta, 1957; Romasheva, 1957) is mainly due to variations in the reaction of the organism to 1st-stage larvae. It has also long been known that reindeer are, on the average, some ten times more affected by the larvae of the reindeer warble-fly (150-200 per head) than are cattle by the larvae of H. bovis and H. lineata (15-20 per head). Since the fertility of the females is almost identical in all species and since the population density of cattle is certainly no less than that of reindeer, we are forced to admit that there must be some factor that controls the number of warble-flies in cattle.

There is every reason to consider that this factor is greater reaction of the organism, which causes considerably more 1st-stage larvae to perish in cattle than in reindeer. It should also be pointed out that the migration period is more than twice as long in H. bovis and H. lineata as in O. tarandi.

A better understanding of the development of parasitism in warble-flies will, of course, call for a knowledge of the physiological features of 1st-stage larvae and of the resultant host-parasite relationship that develops in this period, but even comparatively superficial analysis at the present level of our knowledge of the subject enables us to isolate one factor that fundamentally affects the numbers of the species.

If the host organism combats the parasite most actively when it is a 1st-stage larva, measures to control warble-flies should be undertaken at this stage in the life cycle. This is all the more expedient in view of the economic advantages of controlling 1st-stage larvae: 1) the possibility of destroying the parasites before they cause considerable damage (formation of fistulae, exhaustion of the animals); 2) the possibility of destroying all or the greater part of the larvae by a single application of a medicament when the cattle are in stalls.

It is because of these advantages that control of 1st-stage larvae has recently been receiving ever greater attention in what is as yet mainly a purely empirical development in the technique of warble-fly control. We are greatly indebted to the work of American scholars, who have persisted for some 15 years in the search for methods to control H. bovis and H. lineata in this way.

In view of the specific features of the mode of life of 1st-stage larvae, the development of control measures has mainly been directed to the selection of systemic insectides for administration to the host animals in various ways. Organophosphorous compounds have shown most promise. The best of the many insectides that have so far been tested in the USA are: Dow ET-57 (Trolene, Ronnel) [0, 0-Dimethyl-0-(2,4,5-trichlorphenyl) thiophosphate] in a dose of 110 mg per kg of live weight; Dowco-109 [0-(4-tertiary butyl-2-chlorphenyl) 0-methylamide methylthiophosphoric acid] in a dose of 20 mg/kg or as a spray in an 0.75-1.0% solution (2.5-4 l per head); Bayer 21/199, Co-Ral [0, 0 diethyl-0-(3-chlor-4-methylumbelliferon) thiophosphate] sprayed as an 0.5% emulsion or suspension in a dose of 2.25-6.5 l per head; Dimethoate [0, 0-dimethyl-S-(N-methylcarbamilmethyl) dithiophosphate] in a dose of 10-15 mg/kg. The insectides are given orally or subcutaneously. Bayer 21/199 and Dowco-109 are well absorbed by the skin and can therefore be applied as sprays, emulsions or suspensions. The administration of these insecticides kills 95-100% of 1st-stage H. bovis and H. lineata, 1st-stage larvae (McGregor and Bushland, 1957; Adkins, 1957; Jones, Brundrett and Radeleff, 1957; Brundrett, McGregor and Bushland, 1957; Knapp, Terhaus and Roan, 1958; Graham, 1958; Hewitt, Emro, Entwistle, Pankavich, Thorson, Wallace and Waletzky, 1958; Burns and Goodwin, 1958; Turner and Gaines, 1958; De Foliart, Glenn and Robb, 1958; Neel, 1958; Wade and Colby, 1958; Marquardt and Pritts, 1958; Roth and Eddy, 1959; Drummond and Graham, 1959).

Since 1959 Bayer 21/199 and Dow ET-57 have been officially recommended by the U. S. Department of Agriculture for the control of warble-flies and certain other agricultural pests — blood-sucking flies and flies that cause myiasis, lice and ticks. The spraying of cattle with emulsions and suspensions of Bayer 21/199 has been most widely employed and millions of cattle have been treated. There is a 90-100% mortality of 1st-stage larvae in 99% of the animals treated (Skaptason, 1959). Large scale tests with these insecticides are also being carried out at the present time in Canada (Khan, Thompson and Pelham, 1959; Weintraub, Thompson and Qually, 1959; Weintraub, Rich and Thompson, 1959) and in Britain (Beesley, 1960).

The main disadvantage of these insecticides is that they are fairly toxic to the animals. There was marked poisoning of calves weighing 118-427 kg that had received 40 mg/kg that had received 40 mg/kg and above of Dimethoate and a dose of 80 mg/kg was fatal. Poisoning symptoms also developed on oral administration of 25 mg/kg of Bayer 21/199. When 1-2 week old calves were sprayed with an 0.5% emulsion of this preparation 50% of their blood cholinesterase was inactivated. Spraying with an 0.75% emulsion proved fatal. Dow ET-57 is less toxic; the lethal dose for cattle is more than 400 mg/kg, but the first poisoning symptoms developed at 125 mg/kg (Radeleff and Woodard, 1957). This insecticide also has an unpleasant odor, which affects the quality of the milk in treated animals and makes it unsuitable for use on lactating cows.

The toxic properties of Dowco 109 for cattle have not been sufficiently studied. In some tests slight symptoms of poisoning followed the oral administration of 15 mg/kg (Turner and Gaines, 1958). Other data (Drummond and Graham, 1959) do not reveal poisoning symptoms of considerable reduction of blood cholinesterase from the administration of up to 100 mg/kg.

The search continues in the United States for new systemic insecticides for use in the control of 1st-stage larvae. The object is to produce insecticides that combine high toxicity for the warble-fly larvae with low toxicity for the cattle and the absence of undesirable side effects.

It should also be pointed out that all these insecticides are also highly toxic to 2nd- and 3rd-stage larvae and that their administration therefore kills all larvae, irrespective of their stage.

I have repeatedly stressed the need to develop research on control methods for 1st-stage warble-fly larvae in the Soviet Union (Breyev, 1956a, 1957). Such work has recently been commenced and the first results have been published.

Thrice-repeated oral administration of a 10% solution of chlorophos (Bayer L-13/59) in doses of 75 and 100 mg/kg between October and January caused 97-100% mortality in 1st-stage H. bovis larvae. Four- and five-fold administration of 50 mg/kg of the same preparation reduced mortality to 95% (Khatin, Lur'ye, Kolomiyets and Solov'yev, 1959).

Single administration of 17 and 20 mg/kg of chlorophos in January was ineffective (Potemkin and Gil'denblat, 1959). It is of interest that even a smaller dose (15 mg/kg) causes 97% mortality of 2nd- and 3rd-stage H. bovis larvae if given subcutaneously (Yanovich, 1959). This shows that 1st-stage larvae differ physiologically from 2nd- and 3rd-stage larvae. German research workers (Rosenberger, 1956, 1957; Kretzschmar, 1958; Haupt and Kirschner, 1958) have obtained good results in the control of 1st-stage H. bovis larvae by the use of Neguvon, which is identical in composition to chlorophos, and Emittol, which is similar in composition. Neguvon has also been used successfully in Poland (Kermen, 1958; Zarnowski, 1959).

A number of workers (Voronin, 1958; Khatin and Lur'ye, 1958; Potemkin and Gil'denblat, 1959; Yanovich, 1959) have shown that application of a 3-5% solution of chlorophos to the skin is highly effective against 2nd- and 3rd-stage H. bovis larvae: mortality 91-99%.

Chlorophos is not very toxic to mammals. On subcutaneous injection in rabbits slight symptoms of poisoning were only observed when the dose was 135 mg/kg (Khatin and Lur'ye, 1958). No symptoms were observed in white mice in response to doses of 300 mg/kg (Potemkin, Gil'denblat and Pavlova, 1958). In the tests by Khatin, Lur-ye, Kolomiyets and Solov'yev already cited no symptoms of poisoning were caused in cattle by does of 75 and 100 mg/kg.

Chlorophos has now been recommended for large-scale farming trials in the control of cattle warble-fly larvae in various districts of the USSR.

In Potemkin's tests of Dow ET-57 (1960) oral adminis-

tration of 100 mg/kg to calves in November caused a mortality of 93% of 1st-stage H. bovis larvae by comparison with the control, 75 mg/kg caused 80% mortality of the larvae. No abnormal change in the clinical condition of the animals was observed. Administration of the preparation in May, when all the larvae were already at the second and third stages was quite ineffective. External application of a 6% suspension of DOW ET-57 was not very effective against larvae in warbles (57% mortality).

Successful results were also obtained from the regular feeding of phenothiazine to cattle during the migration period for 1st-stage H. bovis larvae (Ivashkov, 1959). The level of infestation was reduced in some experimental groups by 90-96%. There are indications in the foreign literature, however, that the use of phenothiazine does not always kill warble-fly larvae (Roberts, Mansfield and Cmarik, 1957; Neel, 1958). In addition, phenothiazine is secreted with the milk of lactating cows and there are indications that it is toxic to man (Ellison and Todd, 1957). This preparation must therefore be subjected to exhaustive tests in various districts of the USSR before it can be recommended for general use.

A search for new systemic insecticides for use in the control of 1st-stage larvae of the reindeer warble-fly (O. tarandi) is also being carried out in the Soviet Union. The first positive results have already been obtained. There is difficulty in that there are great differences in the physiology of the reindeer and of cattle. A number of insecticides that have been used with success on cattle have therefore been found to be ineffective when used on reindeer. It is possible that this is due to special features in the reaction of O. tarandi larvae to these preparations, although this is less likely, since the warble-flies of reindeer and cattle are taxonomically much closer akin than are their hosts. In any case we have found from experience that we need to search for new insecticides with different properties.

While acknowledging the great importance of work on systemic insecticides for the control of 1st-stage warble-fly larvae, I must point out a fundamental defect in this work. All these insecticides are organophosphorous compounds, which are toxic to insects largely because they inactivate cholinesterase. To some extent, therefore, they are all, as has been mentioned, poisons to the hosts as well as to the parasites. It also has to be borne in mind that substances that are much more toxic than the initial preparations may develop as a result of the metabolic incorporation of these compounds in the host. Thus a study of Dimethoate metabolism in cattle revealed that metabolites with an anticholinesterase activity 365 times greater than that of the initial compound were formed in the blood (Kaplanis, Robbins, Darrow, Hopkins, Monroe and Treiber, 1959). Since the selection of these insecticides is still largely purely empirical, there is usually considerable delay in studying their pharmacological properties in relation to animals, and nothing is, in general, known about the effect of the drugs themselves and their derivatives formed in the animals on man as a consumer of livestock products. This gives rise to justifiable misgivings that often make it difficult to introduce insecticides of this type into general use.

It would undoubtedly be more progressive to search for methods of controlling 1st-stage larvae by somehow increasing the defensive reactions of the host's organism or by weakening the organism of the larva by methods that do not harm the host. It is clear that success here can only be based on a profound study of the specific features of host-parasite relationships in each species of warble-fly, which also entails knowledge of the physiological features of the larvae and the morphological systems with which these features are associated.

Such a study of the parasite and its relations with its host will undoubtedly also have bearing on the evolution of parasitism in warble-flies. Here there is a close relationship between aspects of the evolution and classification of the group of parasites and the most rational control measures: parallel solution of these problems would show, from our point of view, that the course being followed in research was a progressive one. Only a study of the developmental history of a species in all its complexity and contradictoriness can lead to an understanding of the factors that govern its numbers and to development of the most effective control measures.

In this connection one should note the attempt by Lienert and Thorsell (1955, 1956) to find drugs that will inactivate the collagenase secreted by 1st-stage H. bovis larvae. Since warble-flies are parasites of connective tissue, collagenase probably plays an extremely important part in their life. On the other hand, the metabolitic processes of collagen breakdown are probably far less vital to the hosts than acetylcholine metabolism: the administration of collagenase inactivators will therefore probably be much more toxic to warble-flies than to their hosts.

The immunization of animals against H. bovis and H. lineata larvae was attempted in 1946-1948 in Algeria (Ed. et Et. Sergent, 1950) and more recently in Canada (Khan, Connell and Darcel, 1960). In the first case the animals were injected with a formalin-processed homogenate or with the pure hemolymph of 3rd-stage H. bovis larvae near pupation and in the second case with a homogenate in physiological saline of H. lineata 1st-stage larvae from the gullet (Antigen A) and the same homogenate treated with gallic acid (Antigen B). In Sergents experiments a decline in infestation was only observed in adult animals that had previously been infested. The procedure used in these tests is open to some objection. In Canada the intramuscular injection of calves with Antigen A, followed 17 days later by Antigen B, led to an 81% reduction in infestation, but only in relation to H. bovis larvae. In the authors' view this was due to late injection of the antigens (in December and January), when many H. lineata larvae were already on the point of transition to the second stage. The injection of Antigen A alone was ineffective.

These tests confirm my previously expressed opinion that the resistance of the host organism to warble-fly invasion is mainly directed against larvae in the very early stages of their development in the organism. The fact that antigens derived from H. lineata were effective against H. bovis larvae shows that the method of preparing and using these antigens probably gave rise to nonspecific stimulation of defensive reactions in the organism. Although this work is still in its initial stages, the trend shows promise.

I shall now analyze other factors that affect the numbers of warble-flies, in order to attempt to find other vulnerable points in their life cycle.

Factors Affecting Fluctuations in the Numbers of Warble-Flies. Adult Warble-Flies and Control Measures

The size of the warble-fly population depends in the first instance on the food factor, i.e., on the population density of the host animals in a given area. It is clear that, other conditions being equal, the number of warble-flies will be greatest where there are most host animals, since the fertilized females will then have the greatest chance of laying all their eggs, especially when considerable numbers of animals spend the greater part of the year at pasture. It is in fact true that there is still a high level of infestation (80-90%) in our southern cattle districts (Kazakhstan, Kirghizia) where these conditions are best satisfied (Rudenko, 1957; Doszhanov, 1957; Romasheva, 1959). Kalmykova (1935) found that there was a direct relationship between cattle density and the level of infestation with warble-fly larvae in various districts in Kazakhstan. The level of infestation averaged 22.4 larvae per head at a density of 180 head per ha, 10-.5 at 30 head per ha and 4.5 at 5 head per ha. Grunin (1957) adduces similar data for Pallasiomyia antilopum Pall., which has disappeared from some districts in the USSR, owing to decline in the numbers of its hosts — the saiga antelope.

It is, however, hardly possible to use this factor to control the number of warble-flies, since this would run counter to one of the main trends in the development of livestock farming. The number of animals is already sufficiently large in the main cattle districts to ensure the maximum warble-fly population and any changes are likely to be increases. Nor is the food factor decisive in this case, since infestation is insignificant or absent in many cases when there are plenty of cattle.

The best example of this is that warble-flies are not to be found anywhere in the southern hemisphere, although infested cattle have often been imported. It has long been known that this is due to the fact that conditions in the southern hemisphere are unfavorable to those phases in the development of the warble-fly that take place outside the host, i.e., the pupa and the adult state, since summer in the northern hemisphere corresponds to winter in the southern.

The fact that warble-flies extend quite far to the south

is shown by the fairly high level of infestation in the Pundjab (35% of 41,000 head of cattle investigated — Bishopp, Laake, Brundrett and Wells, 1926) and in Upper Egypt. They are, however, unable to live in the tropics. Their southern limit, as given by various authors (Luehrs, 1958) is determined by climatic factors that although as yet unestablished are unfavorable to the development of pupae and to the life of the adult warble-flies. The most fundamental features are clearly the high temperatures and the humidity of the soil during pupal development.

Pfadt (1947) found that the optimum temperature for the development of H. lineata pupae was 21°C. Only 33% of the pupae survived at 25° and at 30° they all perished. I have found that H. bovis and O. tarandi also fail to complete their development and perish at 30°.

Bruce (1938) has shown that conditions are optimum for the development of H. bovis and H. lineata pupae if soil humidity does not exceed 5% (by weight). At higher humidities a large number of the pupae perished. All the H. bovis pupae perished at a humidity of 22.7% and all the H. lineata larvae at 10.5% and above. Bruce considers that the absence of the warble-fly from the Red River Valley in the USA, despite its presence in the surrounding districts, is due to the high soil humidity.

High soil humidity, associated with regular flooding, and intensive agriculture probably also account for the total absence of warble-flies from the Nile delta (Boutros, 1942, cited by Luehrs, 1958) and the slight infestation of cattle in the United Arab Republic (2% in Lower Egypt and 12% in Upper Egypt) (Eddin, 1955).

Soni (1949) found that high soil humidity was the main factor that prevented the extension of warble-flies in central and southern India. His data shown that the southernmost limit of the warble-fly area (Darjeeling in Eastern Nepal, Kalimpong in northwest Bengal and Shilong in Assam) cattle are only infested (up to 20-30%) in mountain districts with well-drained soils and that warble-flies are totally absent from the adjacent valleys. These examples tend to show that both high humidity and high soil temperatures are limiting factors.

Mustafeyev (1959) found that H. lineata was absent in Azerbaydzhan in mountain districts above 2000 m and in the subtropical zone (Talysh) but present elsewhere in Azerbaydzhan. This is due to the fact that even in mountain districts the last larvae of this species complete their development in the host and fall to the ground by February, 2-4 months earlier than H. bovis larvae. H. lineata pupae are therefore unable to develop in the mountain districts owing to the low temperatures and in the subtropics owing to the high soil humidity.

There are, naturally, no warble-flies or only very few in districts where, owing to the shortage of pastures, cattle are stall fed throughout the year or only driven to pasture in the autumn after the harvest. This is also connected with the absence of the conditions favorable for the development of the pupae and for adult life. For the same reason warble-flies are also absent from Thuringia and eastern Styria (Gebauer, 1958), from districts of the former Poznan province of Poland (Stefanski i Obitz, 1935).

Climatic conditions affecting the life of the pupae and the adult insects are therefore another factor that controls the size of the warble-fly population.

This factor is temporal as well as spatial in effect. A wet humid spring and summer creates unfavorable conditions for warble-flies in the temperate zone, especially in the northern sectors of the warble-fly's range. Infestation by warble-flies is reduced after such years. This has been noted for cattle warble-flies by Blagoveshchenskiy and Pavlovskiy (1930) who found that the infestation of cattle by H. bovis larvae in the Novgorod region was reduced after the very wet, cold summer of 1928 from 76 to 49% in one group of animals (628 head) and from 51 to 18% in another group of similar size. Similar facts are also adduced by other authors (Stefanski, 1949; Gansser, 1951; Luehrs, 1955).

Similar cases have been observed in the reindeer warble-fly. Thus, in the Malozemel'skaya tundra (the southern part of the tundra zone), in 1957 the mean air temperature in June was 8.1° and the mean soil temperature at a depth of 5 cm was 10.1°; the corresponding figures in July were 15.9° and 16.8°. In 1958 the same indices were 5.3° and less than 5° in June and 11.8° and 12.7° in July. In July and August 1957 air temperature was above 15° on 57 days and above 20° on 34 of these days. In 1958 there were 33 days with a temperature above 15° in the same months and 16 days with a temperature above 10°.

The average level of infestation of yearling reindeer with O. tarandi larvae in the Nar'yan Mar Agriculture Experiment Station herd was 70 larvae in the spring of 1958 and 33 larvae in 1959.

Why should the conditions for those phases in the development of warble-flies that take place outside the host have such a basic influence on their numbers? The answer is that the complex of relationships between the parasitic larva and its host remains relatively constant. Although the composition of the animals in a given district and in many cases in different districts varies from year to year in relation to sex, age, health and level of nutrition, such changes are not sufficient to cause noticeable shifts in warble-fly populations.[2] Spatial and temporal variations in external conditions can, on the other hand, be quite significant.

We are here approaching the question of some sort of biological collision brought about in the life of warble-flies in connection with their transition to parasitism. I have already mentioned that warble-flies derived a number of fundamental biological advantages from adaptation to life in capsules of connective tissue: a plentiful supply of rich food and good protection from unfavorable external influences. At the same time, however, there arose an extremely marked difference between the environmental temperatures for the larvae and the pupae and adult warble-flies. The larvae live within ungulates at a constant temperature of 38-39°, while the pupae and the adult warble-flies live in an external medium the temperature of which fluctuates from -5° to 10° and below, when the larvae fall at the end of the winter or in early spring onto snow to 40-50° and above in deserts and semideserts.

Life is naturally often complicated for warble-flies in an environment that is subject to such temperature variations. The flies, which become adapted to high environmental temperatures during larval development, remain largely thermophylic in the other developmental stages, although there is, as we have seen, a slight downward shift in the optimum temperature. Probably owing to the accumulation of considerable fat reserves, the mature larvae that drop off the cattle are relatively cold-resistant and endure a drop in temperature of down to -13° quite well (H. lineata, Pfadt, 1947). The temperature threshold for development of the larvae is also relatively low at around 10°. Even in the reindeer warble-fly, however, the optimum conditions for pupal development are only created at 15-20°, although the greater part of its distribution area lies in the tundra zone.

Adult warble-flies are even more thermophylic. Even in the reindeer warble-fly the lower temperature threshold for the activity of the adult flies is about 14-15° and the upper threshold is approximately 43°, the conditions most favorable to flight are created at between 17 and 27° (Breyev, 1956b). In cattle warble-flies flight and egg-laying usually take place when the air temperature is 15-17° or more, and usually only on sunny days (Bishopp et al., 1926; Savel'yev, 1951; Gebauer, 1958). It is true that Bishopp found one case of egg-laying in H. lineata at 45° F (7.5°C), but he noted that egg-laying in low temperatures occurred in sunlight. Special experiments (Breyev, 1956b) have shown that, as a result of insulation, the body temperature of a warble-fly may be 7-9° higher than that of the surrounding air even within the Arctic circle. In similar experiments which I carried out at Frunze (Kirghiz SSR) with H. bovis, this temperature difference reached 15°.

The soil humidity conditions under which pupae develop are also of fundamental significance for the survival of warble-flies, as has been mentioned. The influence of air humidity on adult warble-flies has not yet been studied.

It is obvious from the foregoing that there are very considerable variations of temperature and humidity in the environment in which the pupae develop and the adult warble-flies live. The fact that these fluctuations often lie outside

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[2]This is because maximum output of livestock products is ensured by maintaining the herd at a level that is optimum for the given district.

the range of optimum conditions affects variations in warble-fly populations.

The features of warble-fly phenology in different climatic zones are also largely dependent on the conditions of pupal life. This is of great importance when determining the time at which different control measures should be carried out in these zones. This is because while the duration of larval development within the host remains fairly constant, the duration of pupal development can vary greatly in relation to climatic or weather conditions. In cattle warble-flies for example development of all stages of the larva takes approximately 10 months, while pupal development may take from 17-20 to 60-70 days depending on temperature conditions at the point of deposition. The conditions of pupal development will therefore be the main factor affecting variations in the total duration of the life cycle and, as a consequence, in the phenology of the separate phases. The period in which the eggs develop and the time between the emergence of the females and the beginning of the egg-laying can both be ignored, since neither normally takes more than 5-7 days. The weather is usually warm enough for the flight of warble-flies when the first flies emerge.

For the sake of greater clairity we shall cite the example of possible phenological changes in cattle warble-flies. We shall assume that in the year under consideration the larvae finished their migration and formed fistular capsules in May, and finished developing and dropped off the animals in the warm weather in July. As a result of this development the pupal stage is rapid and the adult flies emerge 17-20 days after pupation. In the following year the progeny form fistulae in March or early April, rather than in May, and therefore finish their development not in July but in late April or in May. If the temperature is sufficiently high in the given district by this time for the pupae to develop rapidly there will be a further advancement in the date at which fistular capsules appear and at which the larvae finish maturing.

This temporal contraction in the development cycle will continue until the larvae emerge to pupate when temperature conditions are such that the pupal stage lasts for approximately two months. In this case the whole development cycle will last for exactly a year and there will be no further shifts in the onset of pupation, the onset of flight and egg-laying and the appearance of fistular capsules in the following year.

Thus, the time of first egg-laying and, consequently, the time at which the remaining developmental phases are manifested in a given climatic zone is determined by the time at which the temperature is high enough for warble-fly pupae to develop in the surface layers of the soil.

The times at which egg-laying and flight end are also largely dependent on the conditions of pupal development. In the desert zone, for example, cattle warble-flies only fly in the spring, because of the very high surface temperature of the soil (up to 50° and above) as early as the second half of May. Under these conditions all the larvae that drop off the animals then or later perish from overheating. High air temperatures (35° and above) and stron insulation also repress the activity of adult warble-flies (Bishopp et al., 1926). Furthermore, the life span of the adult warble-flies, which is only 3-5 days under normal conditions, is even shorter at these temperatures, and this makes it more probable that the females will die before they have laid most of their eggs.

Since the degree to which their conditions are favorable has such a basic influence on the pupae and adult warble-flies and on natural variations in the numbers of various species, we can also conclude that measures to destroy them at these stages in their development will rapidly reduce their numbers.

Since the pupae are normally scattered over a wide area it is economically impracticable to attempt to control them and there is greater hope of controlling the adult warble-flies. It is also expedient to destroy the adult flies since in many species, as in many other animals, they are the smallest in number and probably do not amount to more than 10-15% of the total number of eggs laid. The fate of the adult fly will therefore probably be considerably more important in the overall population balance of the species than the fate of the egg or the larva.

In how far is it practicable to control adult warble-flies? The main method is to treat the hairs of the hide with persistent contact insecticides. On coming into contact with the animals during egg-laying, the flies are poisoned and perish before they can lay the majority of their eggs. When a large number of flies are gathered round a herd, as is the case with the reindeer warble-fly, a considerable proportion of the flies are affected by the poison during spraying and many of them therefore perish immediately after the herd has been treated. The widely employed method of controlling the reindeer warble-fly was based on this principle (Breyev and Savel'yev, 1954, 1958). If herds are treated at the right time and sufficiently thoroughly with a combined emulsion of DDT and hexachlorancyclohexane, the infestation of reindeer is reduced to a half or a third in the season following the treatment. It takes five or six men no longer than 1 1/2-2 hrs. to treat a herd of 1500-2000.

Experiments in the control of H. bovis by a similar method gave positive results. Savel'yev (1952), who used a 5% oil-based solution of DDT at a rate of 100 ml per head, found that with proper organization it took 1 1/2 seconds to treat one animal. In the Leningrad region the infestation of cattle with warble-fly larvae was reduced from 74 to 3.6% after one season (6 treatments). In Lutta's experiments (1957) the infestation of adult animals in the Sortaval'skiy district of the Karelian ASSR was reduced after two seasons of regular treatment from 60.9 to 35.8%, and the average level of infestation from 5.7 to 0.6 larvae per head. The infestation of more carefully treated young stock was reduced in the same period from 90 to 20% and the average level of infestation from 20.3 to 0.6 larvae per head.

After 8 herds in the Krasnodar subdistrict had been treated for one summer with 3% turpentine-creoline emulsion of DDT and hexachlorancyclohexane and 2% hexachlorancyclohexane larvae (17 in all) were only found in 12 animals out of 581 (2%). In 8 control herds (630 head) there was 37.6% average infestation (2.9 larvae per head). Before the test the corresponding figures for all the herds had been 40% and 3 per head (Andreyev and Krovyakov, 1959). The efficacy of summer treatment with DDT and hexachlorancyclohexane (HCH) has also been confirmed by tests in the Novosibirsk region (Andreyev and Yanovich, 1959).

These results have also been confirmed by tests in the Federal German Republic (Kuehl, 1949, 1950, 1953; Kamm, 1952; Mehls and Reichenbach, 1953). In these mountain pasture tests 8-12 treatments in a season with an 0.1% emulsion of HCH gamma-isomer (1-1.25 l per head) lowered infestation in the following season by 88% by comparison with the control groups. In Gebauer's tests in the Tyrol (1955) infestation was more than halved after summer treatment of the cattle with a 5% solution of DDT (41-45% in the test animals and 92.5% in the controls).

One advantage of this method for the control of cattle warble-flies (especially H. bovis) is that some of the 1st-stage larvae can also be destroyed after they emerge from the eggs and before they penetrate beneath the skin. Since the hairs are not very close-set, they are well wetted by the insecticide spray, and there is plenty of chance for the larvae to come into contact with the insecticide, since they emerge from eggs that normally lie close to the base of the hair and follow the hair down to the skin. Several of the West European authors cited above also noted the destruction of 1st-stage larvae, although the main object of the treatment was to deal with adult warble-flies.

Another promising feature of the method is that it can easily be combined with measures against blood-sucking insects (midges) and ticks. This does not, of course, mean that this treatment alone will suffice to control all these parasites. A special system of measures, based on the biological features of each species, should be worked out for each species or group of related species, but at a given time (season) the measures needed to control various species may be the same. Combined treatment should be viewed in this light. Lutta (1959) has shown that summer treatment with a solution of DDT can be used for simultaneous control of H. bovis, Ixodes ricinus L., I. persulcatus Sch. and horseflies. Andreyev and Krovyakov (1959) also report that measures against adult warble-flies also provided satisfactory protection against horseflies and Ixodes ticks.

The destruction of adult warble-flies by contact organic insecticides is also expedient because it avoids the possibility that populations that are resistant to the insecticides may develop. It is known that the sexual products of adult warble-flies are already mature when they emerge and it is therefore unlikely that any resistance to insecticides which might develop would be passed on.

There is thus every reason to consider that the regular

treatment of animals with persistent contact insecticides during the summer is a method for the control of warble-flies that is worthy of consideration and that should be further studied with a view to its widespread introduction. Points that need to be studied are selection of the most suitable preparation and the spraying equipment that is most suitable for treatment under various conditions, spraying periods and spraying frequency in different regions and the efficacy of the method in combined control of various species of warble-flies, blood-sucking insects and ticks. Since spraying with insecticides does not make very great demands on labor, the method should be of particular interest in cattle driving districts. Chemists and chemical engineers must cooperate with entomologists and veterinarians in the research on all these problems and parallel tests must be carried out in districts in which climatic conditions and cattle raising methods differ.

Another of the biological features of adult warble-flies can be used in their control. Gansser (1957) and Grunin (1959) have shown that warble-flies have special "meeting places" where the sexes congregate for fertilization. After emerging the males fly to these places, where they accumulate in large numbers in an area of a few square meters to await the females. After the females arrive and mate they fly off in search of the host animal to lay their eggs. The sexes always meet in this way, even when the density of the warble-fly population is extremely low. We still have no precise descriptions of the areas where the males of the various harmful species of warble-fly congregate, but if such descriptions are given and the places can be found sufficiently quickly and accurately and treated with persistent contact insecticides, it should be possible to destroy the majority of the males and thus greatly reduce the numbers of the species.

CONCLUSION

We thus conclude that control of 1st-stage larvae and adult warble-flies is most likely, from the biological point of view, to effect the greatest reduction in the numbers of harmful species. This type of control is already possible. But what about the methods for the control of 2nd- and 3rd-stage cattle warble-fly larvae that are already widely used? Should they now be rejected as being ineffective? This approach would be incorrect. Destruction of a harmful species at any stage in its development will certainly effect some reduction in its numbers, and all means at present available should continue to be employed. The object of this article is to show how to proceed in order to achieve the greatest effect with the least effort.

Existing experience shows that even the well organized destruction of 2nd- and 3rd-stage larvae does not always yield the results expected. Warble-flies are extremely specific parasites which can be totally eradicated without any impairment of the biocoenoses. The object of the measures which have been systematically carried out in various countries for some 40 years is total eradication of warble-flies from a given territory. In this respect there has only been slight success as yet, although the insecticides employed ensure 95-100% mortality of all 2nd- and 3rd-stage larvae if properly used. As yet warble-flies have only been totally eradicated in Cyprus (McDonald, 1946; Neave, 1954) and; it is claimed, in some Swedish provinces (Carlstroem, 1952).

It is highly indicative that even in a country where livestock farming is as intensive as in Denmark, where anti-warble-fly measures are extremely well organized, these flies have not yet been eliminated from Jutland, on the mainland. Success was attained on the islands in 1933, 10 years after the commencement of the campaign. In Jutland, where infestation was as high as 80% in places in 1923, it had only been reduced to 15% in the 15 years up to 1938. Shortage of rotenone, the insecticide employed, led to an increase in infestation to 38% during the war. In the postwar period it has once again been reduced but at less than 1% per annum in the 8 years 1948 through 1955 (Aarsberetnings..., 1937-1938, 1948, 1951-1955; Westermarck, 1949; Worden, 1952).

In Switzerland, where cattle farming is long-established and quite intensive, infestation of cattle in the country as a whole had been reduced by 1925, after a 5 year campaign, from 26% to 9%, but has not since been further reduced, as Gansser's data (1951) show, despite regular carrying out of control measures.

These examples prompt the thought that the low efficacy of the campaign in these cases is due to fundamental errors in the approach to the problem and to the selection of the period in the pest's life cycle as well as to organizational difficulties. In fact, when the larvae begin their life in the fistular capsules conditions are, as has been shown, very favorable to them in many respects. My data shown that the mortality of O. tarandi larvae in this period does not exceed 13% (Breyev and Karazeyeva, 1953). Gebauer (1958) also notes that the mortality of 2nd- and 3rd-stage H. bovis and H. lineata larvae is in general insignificant. There is little biological point in attempting to control a pest when conditions are most favorable to it, especially since it is more complicated to combat 2nd- and 3rd-stage larvae than 1st-stage larvae and adult warble-flies. This raises the question as to which periods in the life cycle are most suitable for successful control of warble-flies? This is the question which I have tried to consider in the light of the present state of our knowledge of the biology of warble-flies and control measures.

In conclusion I must touch upon tactical aspects of the campaign. We normally make our greatest efforts against pests when their numbers are large. The main point of attempting to forecast the numbers of harmful species is to be able to predict an increase and to prepare for a campaign against them. This approach shows that we are insufficiently organized and that we do not know enough about the most vulnerable points in the life cycle and about control measures during these periods. The greatest reduction in the numbers of harmful species would be much more effectively secured by maximizing our efforts in years when the numbers are lowest, so that our efforts reinforce the natural declines in the insect population.

In relation to warble-flies this means that we should be most active when conditions for the development of the pupae and for the life of the adult insects are unfavorable, i.e., when the spring and summer are cold and damp in the cold and temperate to warm climatic zones in which the majority of the harmful species are concentrated at the present time. In order to be able to predict natural declines in the insect population we must make regular observations of the variations and establish the actual meteorological indices, especially those of temperature and humidity, which are favorable or unfavorable to these stages in the development of warble-flies.

One can predict fairly confidently that there will be a rapid reduction in the numbers of warble-flies, leading to the total elimination of some species over considerable areas, if we combine control of 1st-stage larvae with destruction of the adult flies, organize our work properly and make our greatest efforts in years when natural conditions are unfavorable to warble-flies.

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ON THE MORPHOLOGY OF THE TRACHEAL SYSTEM IN GALL-MIDGE LARVAE (DIPTERA, ITONIDIDAE) AS RELATED TO THEIR BIOLOGY

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In the study of plant galls and teratomata as host biotopes offering a particular type of enclosed environment, one aspect of the problem is to discover how these formations influence the organo-genesis and morphological adaptations in the stimulators. The organization of the larvae is particularly interesting in this connection, for in most cases it is these that are responsible for the formation of the galls or teratomata.

Examining the morphology and detailed structure of the alimentary canal in the larvae of a number of gall-making midges, we find that evolution has produced structural simplifications in this family, in the form of narrowed nutritional specialization, the insects becoming highly host-specific and developing acute topological preferences. In some cases these simplifications have gone so far that the structural plan of the larval alimentary canal has become a peculiar kind of "reversal" of the ancestral morphology, as in Anisostephus betulinum Kieff. On the other hand, simplification of the alimentary canal is accompanied by complicated differentiation and strong development of a pair of fore-intestinal salivary glands.

Whether towards simplification or towards greater complexity, these organizational developments are adaptational and closely bound up with the gall-midge larva's biology as a plant parasite and with the role of galls and teratomata as host biotopes.

The discovery of evolutionary morphogenetic changes in the endosomatic organs of gall- and teratoma-producing insects (Slepyan, 1960) has also brought order into the problem of how the ectosomatic organs are influenced by galls and teratomata as habitats. Here the tracheal system is interesting, since because of the known connection between its morphology and the life habits of the species. Galls and teratomata vary in regard to histological characteristics, which, in turn, condition the microclimate in which the tracheae function. Variations of essential importance are those of the tissue thickness surrounding the larval chamber, the character, degree of lignification and thickness of the cellular walls in these tissues during the growth of the formation, the number, size and distribution of the interstitial cells and, lastly, the gas exchange between the internal environment of the galls and teratomata on the one hand and the atmospheric habitat of the plant hosts on the other. As a result of these differences the larvae of the gall- and teratoma-makers are subjected, during the ontogenetic process, to the influence both of the microclimate created in the gall itself and of that of the host-plant's habitat. In a number of cases the former may be moister and may suffer more abrupt termperature variations than the phytocoenotic microclimate. This makes for the penetration of gall- and teratoma-makers into habitats where the conditions of existence are extreme and also stabilizes the conditions of their parasitism on plants.

A further aspect, relevant to all that has been said above, is that of the kind of influence exerted by plant galls, as habitats, on the tracheal systems of their stimulators, which are, topologically and as regards host, specific plant parasites.

The answer can be found only by examining the tracheal system of the larvae of species that stimulate galls open, in varying degrees, to the direct action of the microclimate surrounding the affected organ of the host-plant.

We have studied the tracheal system in five species of phytophagons midges and one species of predaceous gnat for comparison. The species studied were:

1) Macrodiplosis dryobia F. Lw., the larvae of which infest the surface of Quercus robur L. leaves under the notches of the lobes, in the microclimatic conditions in which the affected shoot is situated;

2) Perrisia fraxini Kieff., the larvae of which develop in galls formed from the central vein of the Fraxinus excelsior L. leaf; the closed galls are well aerated and the larvae are exposed towards the end of ontogenesis;

3) Perrisia urticae Perr., the larvae of which occur in the blister-like thin-walled galls formed on the leaf blade of Urtica dioica L.; the exit aperture of these galls is rather small;

4) Iteomyia capreae Winn., the larvae of which develop in galls on Salix caprea L. leaves; the larval cavity is in the tissues formed in the process of gall-making and is surrounded on all sides by a multicellular layer of the secondary gall meristem rising out of the mesophyll, which is covered with a lignified parenchyma towards the periphery of the gall; the exit opening in the gall forms towards the end of the larva's ontogenesis;

5) Lasioptera rubi Heeg., the larvae of which are incapsulated in the expanding parenchyma of young raspberry shoots during the formation of a gall; the microclimate of the larval chambers in the galls caused by this insect has no direct connection with that of the habitat of the affected plant.

For comparison, the morphology of the tracheal system of the predaceous larvae of Phaenobremia sp., which inhabit Aphis pomi Deg. colonies on apple trees, was also studied.

The tracheal morphology was studied in vivo. The work was carried out at the Faculty of Invertebrate Zoology in the University of Leningrad on material collected in the vicinity of Leningrad in June 1954.

An examination of the tracheal system in adult larvae of the species under study showed that all of them had nine pairs of functioning spiracles, one of which was prothoracic and eight abdominal, situated on the first to eighth abdominal segments. The same number of spiracles has been found in gall-midge larvae described in the literature — for example Cecidomyia brachyntera Schwaegr. (Gernet, 1867) and Rhabdophaga saliciperda (Dufour) (Sen, 1939). Mayetiola destructor Say larvae are exceptional, having ten pairs (Znamenskiy, 1926; Haseman, 1931), but nine of these are closed at the beginning of the larva's ontogenesis. By way of comparison it is interesting that the first-instar larvae of Monarthropalpus buxi Lab., which develops in the mesophyll of Buxus sempervirens L., is completely apneustic (Hamilton, 1925).

A number of peculiarities distinguish the tracheal system morphology both on the ventral and on the dorsal sides of the body. On the ventral side, at some distance from its lateral margin, there are two tracheal trunks running laterally from the head to the anal segment of the abdomen and giving off slender terminal branches (Figs. 1, 2, 3, 4; ventral side). Between these stems, in the region of the anterior half of the prothoracic segment, there is a smallish tracheal bridge, which in some species bends outwards to near the end (Lasioptera rubi Heeg., Fig. 1, 2; Perrisia fraxini Kieff., Fig. 4, 2), and in others to below the middle (Phaenobremia sp., Fig. 2, 2; Perrisia urticae Perr., Fig. 3, 2), of the first thoracic segment. Branches, each of which in turn undergoes further division, spread downwards from the bottom of the bend, and in some species upwards too (Perrisia urticae Perr., Fig. 3, 2), as well as laterally.

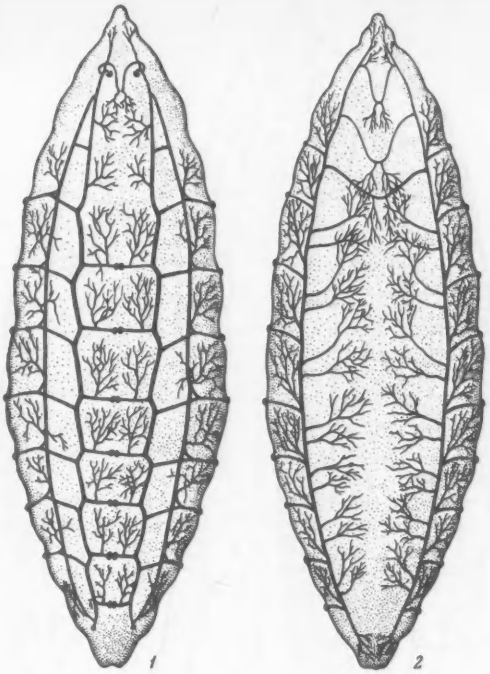

Fig. 1 - Lasioptera rubi Heeg. larva. 1 - dorsal view; 2 - ventral view.

There is a similar bridge between the two tracheal trunks in the mesothoracic segment; here both branches may be turned forwards (Phaenobremia sp., Fig. 2, 2). An identical bridge occurs in the metathoracic segment.

Separate tracheal branches connected to the alimentary canal run in pairs from each of the principal ventral tracheal trunks between the spiracular branches in the anterior half of each of the first seven abdominal segments, towards the median line of the body and forwards. The anterior branches in segments 1-4 (Phaenobremia sp., Fig. 2, 2) may extend forward to a length almost one and a half times that of the segment, bending near the medial line of the body and subdividing only at the very end. On the other hand, the anterior and posterior branches may not differ so widely, as in Lasioptera rubi Heeg. (Fig. 1, 2) and Perrisia fraxini Kieff. (Fig. 4, 2). In the first case the posterior trachea is usually more branched, although it is several times shorter than the other; in the second case the anterior trachea is the more branched and is roughly twice as long as the other. In particular species (Phaenobremia sp., Fig. 2, 2; Perrisia urticae Perr., Fig. 3, 2; Perisia fraxini Kieff., Fig. 4, 2), which subdivide within the limits of the individual segments.

The tracheal system of final-instar midge larvae is accordingly metameric and bilaterally symmetrical on the ventral side.

On the dorsal side of the body the tracheal morphology is different and a great deal more complicated. A pair of thick dorsal tracheal trunks ending anteriorly in branches extends from the head to the anal segment, nearer the medial axis of the body. At the beginning of the prothoracic segment or nearer its middle these trunks are joined by a tracheal bridge bent out towards the hind part of the body. Near the middle of this bridge run paired tracheal branches which themselves subdivide terminally; in some species these run downwards, in others upwards (Phaenobremia sp., Fig. 2, 1; Perrisia urticae Perr., Fig. 3, 1; Perrisia fraxini Kieff., Fig. 4, 1). In the region of the mesothoracic and metathoracic segments there is also a terminally subdividing tracheal branch on each side of the body; the proximity of these branches to each other varies in different species.

In the region of the anterior borders of the second to eighth abdominal segments, medially and almost at right angles to each dorsal trunk runs a branch that terminates in an ampulla (Fig. 7; Iteomyia capreae Winn., Fig. 6). These ampullae are contiguous along the median line but not anastomotically joined. The dorsal trunks are thus joined only in the thoracic segments. The presence of ampullae is a distinctive feature of the tracheal system of midge larvae, but their role is not clear; comparable formations are not known in other insect larvae.

Halfway from the dorsal trunk to the ampulla there are usually two much subdivided branches running forward, one on each side of the body, forming secondary and tertiary branches and even branches of the fourth and fifth orders. In some species (Perrisia fraxini Kieff., Fig. 4, 1; Perrisia urticae Perr., Fig. 3, 1) there are two pairs of ampulliferour tracheal trunks at the boundary between the seventh and eighth abdominal segments, instead of only one. Subbranches of these trunks may be lacking (Perrisia urticae Perr., Fig. 3, 1).

A spiracular branch, without subdivision, starts from each dorsal trunk, in the region of the preanal segment, as in the case of the prothoracic segment.

Laterad of the dorsal trunks, beginning in the region of the first and second thoracic segments, there is yet another pair of thin tracheal trunks extending along the body. In the region of the eighth abdominal segment these merge with the dorsal trunks, in some cases giving off branches into the anal segment (Perrisia fraxini Kieff., Fig. 4, 1). Spiracular branches lead off at an acute angle from these trunks at the anterior ends of the first to seventh segments, one on each side of the body in each case. Each spiracle opens on a slight protuberance of the body.

From each of the minor spiracular trunks a trunk

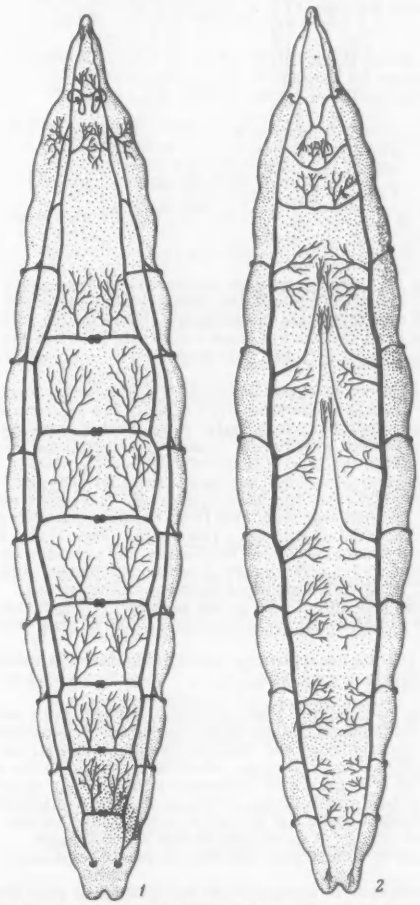

Fig. 2 - Phaenobremia sp. larva. 1 - dorsal view; 2 - ventral view.

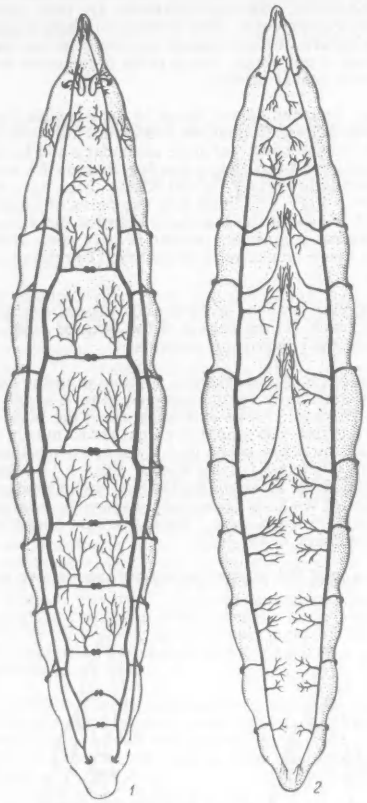

Fig. 3 - Perrisia urticae Perr. larva. 1 - dorsal view; 2 - ventral view.

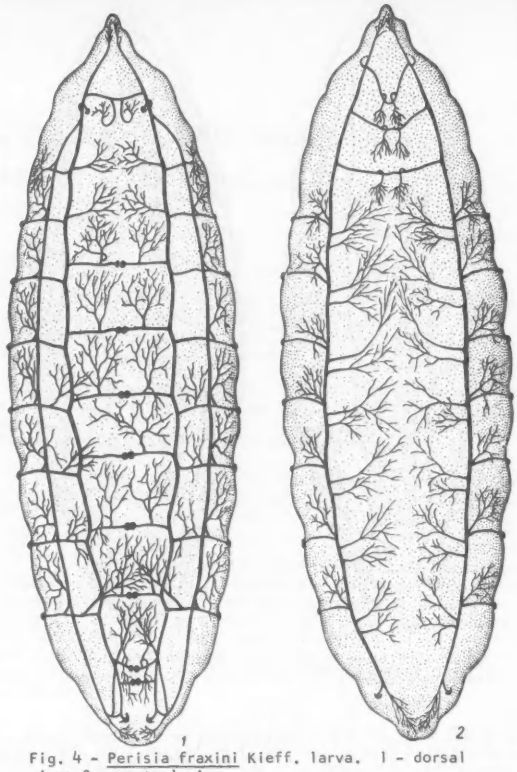

Fig. 4 - Perisia fraxini Kieff. larva. 1 - dorsal view; 2 - ventral view.

branches off, running towards the dorsal surface and caudad. These merge with the dorsal trunks below the branches that terminate in ampullae. Whereas the latter branches draw the central trunks together, those of the lateral longitudinal trunks pull them apart.

In a number of cases (Perrisia fraxini Kieff., Fig. 4, 1) tracheal branches extending over roughly two segments' length and subdividing terminally run cephalad from the point where the lateral longitudinal trunks merge with the dorsal trunks. From the lateral longitudinal trunks, between the first and eighth abdominal segments and above the point where the spiracular tracheae branch off, there may also be heavily branched tracheae, one from the anterior side of each lateral trunk (Lasioptera rubi Heeg., Fig. 1, 1). A pair of tracheal trunks branching terminally and crossing each other, running from the lateral longitudinal trunks in the region of the eighth abdominal segment and extending cephalad to a length of nearly two segments, is a characteristic feature of Macrodiplosis dryobia F. Lw. larvae (Fig. 5).

The tracheal morphology is thus also dorsally metameric and bilaterally symmetrical.

As we see, both in phytophagous and in predator midge larvae, the tracheal system is peripneutic and no different morphologically from the tracheal system of the larvae of Mycetophilidae and Sciaridae, which are related to the midges. Such a plan of the tracheal system is believed by a number of authors to be archaic (Knab, 1915; de Meijere, 1917). It has not undergone substantial variation in the midge larvae, although the biology of these insects has become more specialized in comparison with that of related families.

The absence of change in the morphological plan of the tracheal system in gall-making midge larvae, set against the evolutionary change in the morphological differentiation of the alimentary tract in these larvae under the influence of galls and teratomata as host biotopes, indicates that phylogenetic variations in one set of organs does not necessarily entail changes in others.

Examining the overall morphological picture of the tracheal system, we must emphasize four points. The reduced number of spiracles is noteworthy. While there are ten pairs of spiracles in the hypothetical ancestors of the insects, and usually the same number in the Pterygogenea, the midge larvae, with the exception of Mayetiola destructor Say, have nine pairs. This is progressive specialization. It is also, however, a feature of the Sciaridae and Mycetophilidae (Frey, 1942; Shaw, 1953) and so cannot be regarded as due to the influence of abnormal plant formations as habitats. Secondly, there is the lack of anastomoses between the dorsal tracheal trunks on the abdominal segments, since each of the metamerically branched minor trunks terminates in an ampulla — a small air sac. The absence of anastomoses is a primitive feature, emphasizing the archaic character of the morphological plan of the midge larva's tracheal system. Although it is evidently of secondary origin, (it does not exist in Mycetophilidae or Sciaridae), its functions and origin are not clear. Here we must mention the single known instance of a lack of ampullae combined with the presence of anastomoses of the dorsal tracheal trunks in midge larvae: namely, in the larvae of the resin-infesting Cecidomyia resinicoloides Wlm. (Williams, 1910). Thirdly, the tracheal systems of midge larvae are completely homonomous, a further mark of their primitive character. Finally, the tracheation of the abdominal body segments is strongly developed. Here the large number of tracheal branches in larvae of Lasioptera rubi Heeg. and Perrisia fraxini Kieff., due to their development in closed galls, is noteworthy.

As host biotopes, then, abnormal plant formations do not bring about major changes in the morphogeny of the tracheal system of midges, but they do lead to an increase in the size of the abdominal tracheal system in the larvae

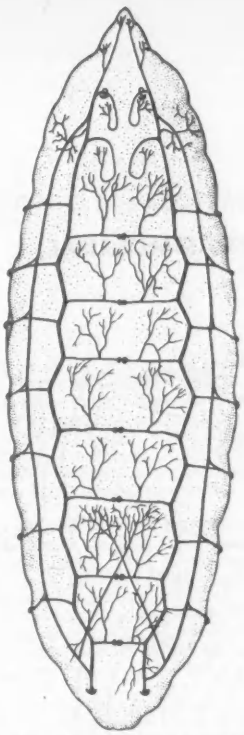

Fig. 5. - Macrodiplosis dryobia F. Lw. larva: dorsal view.

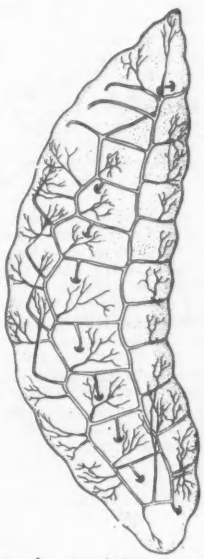

Fig. 6 - Iteolyia capreae Winn. larva: lateral view.

of those species whose environments are isolated from the direct action of the microclimate in which the invaded organ of the host plant develops.

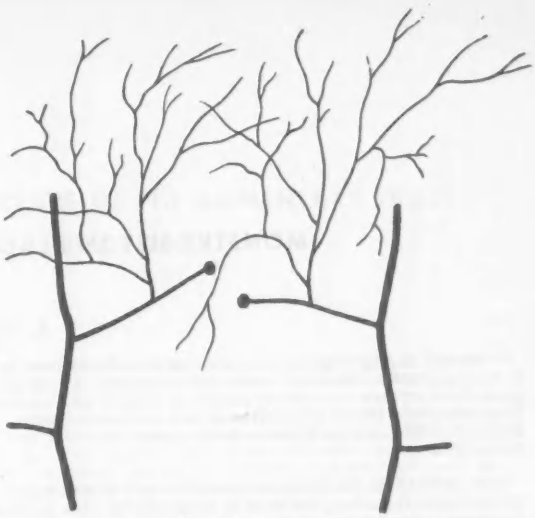

Fig. 7 - Perrisia urticae Perr.: tracheae of one of the median segments of the larva; dorsal view.

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MONSTROSITY IN BLACK FLIES (DIPTERA, SIMULIIDAE)

A. YE. TERTERYAN

Hardly any information on monstrosity in black flies is to be found in the literature known to the author. Cases of gynandromorphism and intersexuality in certain species have been described (Puri, 1933; Grenier and Bertrand, 1949; Rubtsov, 1958), but as Rubtsov notes, these cases are extremely rare.

It seems that black fly monstrosities are indeed highly exceptional, for among the tens of thousands of flies we have examined, only two cases of structural abnormality of the genital appendages have been detected. These occurred among flies infesting cold bodies of water in mountain regions. They are described below.

Cnephia terterjani. Male (Fig. 1:a, b). Hatched from pupa taken from the source of a brook near n. Ovit (Aparan district, Armenia). Right gonopod in male normal, left gonopod a good deal smaller than normal. Stylus and coxite of left gonopod reveal structural malformation. Exterior and interior walls of distal margin of coxite abnormally enlarged; stylus short and conical, with a broad proximal excision.

Eusimulium delizhanense. Male (Fig. 2:c, d, e). Hatched from pupa taken from the source of a brook near Dilizhan (Armenia). In this individual the right gonopod has a malformed stylus, somewhat shorter and wider than normal. Interiorly, just above the proximal indentation, this stylus bears a transversally protruding evagination, the base of which is slightly narrower than the width of the stylus.

These examples of abnormalities point to the rarity of the phenomenon in black flies, but may also help towards correctly evaluating certain morphological structures occurring in the process of individual growth.

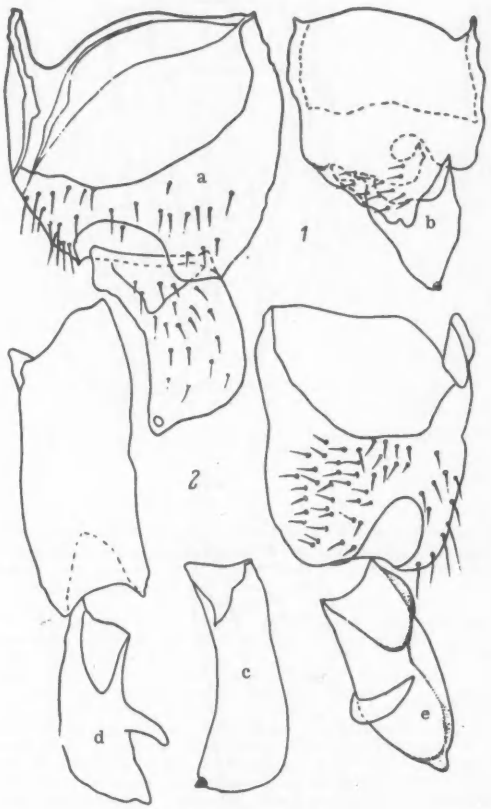

Fig. 1 - Gonopods of male of Cnephia terterjani Rubz.: A - normal; B - abnormal. Fig. 2 - Gonopod sclerites of Eusimulium delizhanense Rubz.: c - normal stylus; d - gonopod with abnormally developed stylus, lateral view, e - as d, front view.

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POSTEMBRYONIC DEVELOPMENT AND STRUCTURE OF THE ALIMENTARY TRACT IN LITHOBIUS FORFICATUS L., (CHILOPODA)

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The first descriptions of the alimentary tract of the Lithobiidae are to be found in Treviranus (1817). Later the intestine was described with varying degrees of fullness and accuracy by a number of investigators (Dufour, 1824; Plateau, 1876; Sograff, 1879; Sograff, 1880; Gibson-Carmichael, 1883-1885; Vogt and Jung, 1889-1894; Leger and Duboscq, 1902), but these studies are outmoded, fragmentary, and not always sufficiently convincing.

The subject of the present paper is Lithobius forficatus L. The adult centipedes were obtained from the Botanical Gardens of Leningrad University. The larvae were reared in the laboratory. I have described how to keep and breed Lithobiidae in captivity and the research technique in other papers (Kaufman, 1960, etc.). I need only add that a fixing fluid was injected into the body cavity to consolidate the tissues and facilitate preparation of the intestine in adult centipedes.

The first stage of postembryonic development in Lithobius — the foetus — has an undeveloped alimentary system that still has indications of a clearly embryonic character. The fore intestine (or stomodaeum) of the foetus commences at the oral cavity and continues to the segment of the second pair of walking legs; it is a slender tube, slightly broadened at the rear end. The stomodaeum is enclosed in a fine muscular sheath consisting of inner longitudinal and outer circular fibers. The epithelium of the stomodaeum is made up of small prismatic cells with utricular nuclei in the apical portion. The boundaries of the cells are not distinct. The varying height of the cells leads to the formation of four ridges along the intestine. The free surface of the epithelium is covered with a fine chitinous lining. The stomodaeum terminates in an already formed cardiac valve. Both the fore and the hind intestine already open into the mid intestine at this stage. The fore intestine does not undergo basic modifications in the later stages of development.

The hind intestine (proctodaeum) of the foetus is similar in histological structure to the fore intestine, save for the disposition of the muscle layers, the longitudinal fibers being outside the circular fibers. The hind intestine connects with the mid intestine in the segment of the seventh pair of legs. In the same segment the proctodaeum forms a loop, which is retained for almost all the anamorphic development and is clearly an adaptation to an anamorphic mode of development. The epithelial wall of the proctodaeum is made up of high (approx. 11 μ) cylinder cells with large (9 μ in diameter) nuclei. As in the stomodaeum, the walls of the hind intestine in the foetus form four ridges which are smoothed out in the anal region. The proctodaeum is approximately 33 μ in diameter. In the last four stages of postembryonic development, the mode of which is epimorphic, the hind intestine is extended and loses its loop. Apart from increase in size and in the number of longitudinal folds (5-6) it also does not undergo fundamental histological changes.

The mid intestine of a larva that has just emerged from the egg capsule is still markedly embryonic in nature. There is still no true intestinal epithelium. The wall of the intestine is a thin layer of homogeneous plasma that stains badly, with a few irregularly distributed but large nuclei (approx. 3μ in diameter). Strands of plasma, the loops of which are tightly packed with yolk (Fig. 1) branch out from the peripheral syncytium. Separate cells that function as vitellophags are often encountered in the yolk. They are elongated, rounded or amoebiform. Although the mesenteron is in essence a syncytium at this stage, there are already weakly differentiated but quite distinct goblet cells at its extremities, i.e., where it adjoins the fore and hind intestine. These are particularly clear in the vicinity of the proctodaeum.

Extremely active foci of cell proliferation are formed in the stomodaeal and proctodaeal areas (especially in the latter). They supply a part of the cell material for the future epithelial wall of the intestine, but the major part of the cell mass is formed from the peripheral syncytium. The syncytial nuclei begin to proliferate and areas of plasma are consolidated round some nuclei. These consolidated areas are still irregular and have branches that are often connected to the plasma strands (Fig. 2).

The vitelline spheres simultaneously begin to be dissolved. Sometimes the large spheres break down into smaller ones and sometimes they become spongy and disentegrate. They also seem on occasion to dissolve from the edges.

The spheres are stained bright red by Mallory's method, and the substance obtained from their dissolution is a light blue; there is transitional coloration at the edges of the dissolving spheres. This may possibly show that the dissolution is enzymatic. The vitelline spheres may also be incorporated in the plasma of cells that separate them from the syncytium. The number of cells formed from the syncytium gradually increases. These cells become rounded and lose their branches.

It should be noted that the syncytium does not break down into cells throughout its extent, but at separate foci, and that therefore an extensive area of syncytium may still be found adjacent to a group of cells. Resorption of all the yolk occurs at the end of the foetal stage or in the next stage, by which time a cell wall has been formed throughout the mesenteron. The young cells, apart from the cells in the vicinity of the proctodaeum, begin intensive absorption of the substance of the disentegrating vitelline spheres. The plasma of each cell is tightly packed with vacuoles of this substance, which is gradually utilized by the cell. The cavity of the intestine develops. The young epithelial cells are broad and shallow and taper slightly from the poles; their free edges are rounded. The plasma of these cells is homogeneous and its structure is indistinctly cellular. The nucleus is situated basally.

At this stage the larva commences active feeding. In subsequent development the number of epithelial cells is considerably increased and they become narrow and long. Total replacement of the intestinal epithelium has not been observed.

The fore intestine, or oesophagus, of the adult extends to the segment of the second or third pair of legs. The diameter of the oesophagus is initially small, but subsequently increases greatly (approx. to 200 μ). The epithelial cells of the oesophagus do not have distinct boundaries. The nuclei lie in the center or in the apical half. The cuticular lining of the oesophagus is relatively thick and forms various uneven surfaces which are apparently utilized in pulverizing the food. These uneven areas increase in size towards the cardiac valve and give way to 5-6 longitudinal folds of varying height (Fig. 3). The epithelium is also drawn back into these folds. Small but sharp chitinous spinules are formed on the cuticle in front of the cardiac valve, with their points facing the valve. These spinules prevent the counterflow of food. The folds of the oesophagus project slightly into the lumen of the mid intestine to form the small cardiac valve. The disposition of the muscle layers is the same as in the larvae [among insects the

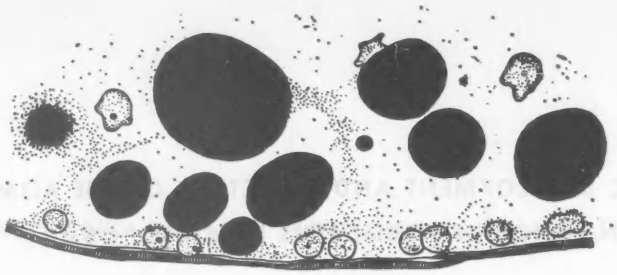

Fig. 1 - Part of the mid intestine in the foetal stage.

arrangement of the muscle layers is reversed in the Ephemeridae (Grandi, 1950), among centipedes in Symphyla (Tiegs, 1945) and in the Pauropoda (Tiegs, 1947)]. The muscle sheath of the extremities of the oesophagus has powerful sphincters. The food enclosed in the oesophagus by the sphincters is ground by muscular contractions of the oesophageal wall (as can be seen if a lightly anaesthetized animal is dissected). In the vicinity of the cardiac valve the external longitudinal muscle strands pass between the circular fibers and are continued as the outer layer in the mid and hind intestine, as in Geophilus (Kaufman, 1960) and in Cryptops (Balbiani, 1890).

The mid intestine of the adult extends to the segment of the eleventh pair of legs, and is approx. 0.5 mm in diameter. There are 35-40 longitudinal muscle clusters along the external wall of the mid intestine, each of which usually consists of two muscle fibrillae. There is a layer of circular muscles beneath the longitudinal muscles. This arrangement of the muscles of the mid intestine is peculiar to almost all insects [except midge larvae, in which the mid intestine is without musculature (Bruk, 1930)]; in the Pauropoda the muscle layer of this sector is syncytial (Tiegs, 1947).

The oesophageal epithelium forms the internal lining of the mid intestine in Lithobius. As in Peripatopsis (Manton and Heatley, 1937), Geophilus (Kaufman, 1960) and Cryptops (Balbiani, 1890), the intestinal epithelium of Lithobius is divided by shallow intersecting grooves into small groups of cells, that are not, however, as clearly delineated as in Peripatopsis and Geophilus. There is intensive proliferation of nuclei at the bottom of the grooves that separate the cell clusters, and they can therefore be compared with the regenerative crypts of insects. The younger cells are situated at the edges of the cell clusters. Note that mitosis has often been found in the central sector of the basal half of a cell cluster; new cell formation must therefore also occur here. The cell structure of the epithelium of the mid intestine is dimorphic and consists of cylinder and goblet cells.

This dimorphism is also found in the mid intestine of Peripatopsis (Manton and Heatley, 1937), Geophilus (Kaufman, 1960), Cryptops (Balbiani, 1890), Pleocoptera, Ephemeroptera, and lepidopterous larvae (Shvanvich, 1949) and in Tetrodontophora (Jura, 1958), although in this latter case Tomocerus and Linella have a homomorphous epithelium (Boelitz, 1933).

The cylinder cells are long, slender columns that taper to the base. The plasma is thicker in the apical ends of the cells, where there is a delicate striation (rhabdorium), which is, however, not always visible. In the lower half of the cell there is an utricular or oval nucleus with 1-2 nucleoles. The nuclei of the crypts and the younger cells are rounded, contain more chromatin grains and stain more deeply. The structure of the cylinder cells is dependent on their physiological state. Thus the cell plasma is homogeneous and cellular in structure when at rest. The nucleus is in the lower part of the cell. The apical margin of the cell is sharply defined. The plasma contains many vacuoles of varying numbers and dimensions that stain well. These vacuoles appear immediately; the growth or coalescence of several vacuoles into one has not been observed. There are fewer vacuoles in the lower half of the cell than at the apex. When it penetrates through the free edge of the cell the vacuole discharges its contents into the lumen of the intestine; the vacuole may pass entirely into the lumen and there disintegrate; cases of the disintegration of vacuoles immediately in the cell plasma have been observed.

During the act of digestion the apical margin of the cell becomes indistinct, the cell is extended and the nuclei migrate into the upper third and are noticeably elongated. The vacuoles disappear in the plasma and are not so receptive to staining. There are goblet cells scattered among the cylinder cells. They are especially numerous near the hind intestine. Goblet, or secretory, cells have a rounded or oval upper part and a long slender stem. There is never a rhabdorium on the apical margin of a goblet cell. The nucleus is elongated or rounded, and is situated in the stem

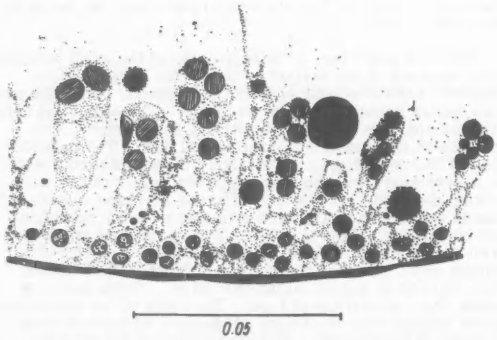

Fig. 2 - Formation of the cells of the mid intestine.

Fig. 3 - Cross section through the middle of the fore intestine in the adult.

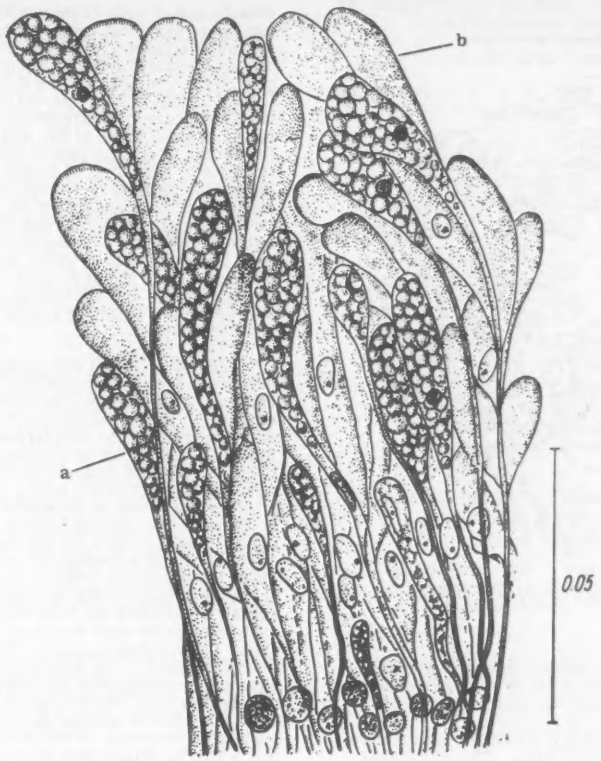

Fig. 4 - Epithelium of the rear extremity of the mid intestine in the adult. a - goblet cell; b - cylinder cell.

in young cells and in the upper stem or apical half in older cells. The whole upper (broad) part of the cell is tightly packed with small uniform vacuoles, which can be stained by the hematoxylins of Heidenhain and Benda, and which stain a bright red by Mallory's method. The plasma of the wide part and of the stem is less receptive to staining.

Vacuoles appear in quite young cells and increase in number as the cell grows. An adult cell rarely reaches the lumen of the intestine, since goblet cells are usually shorter than cylinder cells. On secretion the contents of the vacuoles pass between the cylinder cells. After discharge of the secretion, the former sites of the vacuoles can be seen in the plasma. When Lithobius was fed on meal worms injected with neutral red, the goblet cells did not stain but remained as yellowish-white spots against the rose ground of the stained cylinder cells.

The literature is full but contradictory on the cell composition of the epithelium in the mid intestine of Atelocerata. Some authors assert that the intestinal epithelium consists of cylinder cells (Kowalewsky, 1887; Faussek, 1887, et al.); others assume that both goblet and cylinder cells are present (Verson, 1905; Deegener, 1909, et al). Adlerz (1890) has suggested that all the cells of the alimentary epithelium are identical and that the morphological distinction that is nevertheless to be observed may be due to their different physiological activity at a given moment. Buchmann (1928) assumed, when dealing with the cell composition of the mesenteron, that the goblet cells of the intestine of lepidopterous larvae are not secretory but exhausted cylinder cells. I assume from a study of a large number of mounts of the intestine of Geophilus and Lithobius that the epithelial cells of their mid intestine consist of two types of cells that are never converted into each other and that are not different phases in the physiological activity of cells of one type.

Furthermore, the majority of the goblet cells in Geophilus and Lithobius are to be found in the caudal region of the mid intestine and are, as has been noted, of different origin.

A fine film, the peritrophic membrane, forms around a particle of food passing through the mid intestine. In Lithobius the peritrophic membrane is layered. Its inner layer is formed by cells in the region of the cardiac valve. The remaining layers are secreted by the apical extremities of the intestinal epithelium. The membrane is only secreted where the particle of food is in contact with the epithelium. The apical extremities of the cells, consisting of the denser plasma and rhabdorium envelop the particle. The formation of the peritrophic membrane is somewhat similar in the Trichoptera (Martynov, 1903) and in silkworms (Ertogroul, 1929). The peritrophic membrane is not formed in Lithobius except during feeding.

The border between the mid and the hind intestine is marked by an annular line carrying the openings of two Malpighian tubules. It should be noted that Daiber (1921) and Dogyel' (1938) were in error in stating that there are two pairs of Malpighian tubules in the Chilopoda. In fact chilopods have one pair of long thin tubular vessels with a slight enlargement, the ampulla, where they enter the intestine.

The epithelial lining of the ampulla differs somewhat from that of the tubule, in that the cells are narrower and longer and the nuclei are basally disposed. The epithelial cells of the tubules are cubic and the boundaries are more distinct, especially basally, although the apical extremities are eroded. I did not detect the rhabdorium observed by Palm (1954) in the Malpighian tubules of the Lithobiidae and Geophilidae, nor have they been observed in the Malpighian tubules of Cryptops (Wang and Wu, 1947).

The hind intestine of Lithobius is a short straight tube approximately 350μ in diameter. It consists of the same layers as the preceding sections of the alimentary tract. The disposition of the muscle layers is the same as in the mid intestine but they are thicker (especially the circular muscles). The epithelial cells are very similar to those of the oesophagus, but almost twice as large (approx. 28μ tall in the fore intestine and 57μ in the hind intestine. Examination of sections shows that the cell bases are hexagonal. The epithelium forms 4 large and 2 smaller folds at the fore end

Fig. 5 - Cross section through the middle of the hind intestine in the adult.

of the hind intestine. In the first third of the hind intestine the folds form uneven edges, apparently to enlarge the surface (Fig. 5), but are smothered in the anal region.

The area between the fold sides is filled with connective tissue in which lie long tracheal branches. These tracheae originate in two large trunks which extend to the intestine from the last pair of stigmata. At the junction of the mid and hind intestines the longitudinal folds curve towards the center of the lumen of the intestine to form the pyloric valve. Access to the hind intestine can be completely cut off when this valve is closed by the powerful sphincter. There are only slight structural differences between the pyloric valve of Lithobius and that of Geophilus and Cryptops.

GENERAL COMMENTS

In considering temporal shifts in the formation of organs (heterochrony), Mehnert (1897, 1898) developed the theory of retardations and accelerations and linked the phenomena of heterochrony with progression and regression in the development of organs. According to Mehnert, organs that are progressing are formed early and develop more rapidly (acceleration), while organs that are retrogressing are slower to develop and are formed later than normal organs (retardation). Study of the development of the respiratory (Kaufman, 1959) and alimentary (Sograff, 1883) systems in the Geophilidae and Lithobiidae shows, however, that Mehnert's assertion that late formation is evidence of the reduction of an organ is not always justified. Although both the alimentary and tracheal systems are very slow to develop, their formation occurs in the postembryonic stage of development in both the Geophilidae and Lithobiidae. Nevertheless, the tracheal and respiratory systems of chilopods are certainly not in a state of phylogenetic reduction. Severtsov (1939) has also shown, by reference to the development of the extremities in legless lizards, that Mehnert's hypothesis is untenable.

The epithelium of the mid intestine in the Lithobiidae is of dual origin: the central portion of the mesenteron is formed from the syncytium, a fine film covering the yolk. This syncytial film is evidently the initial vitelline endoderm, from which part of the ultimate epithelium of the mid intestine is formed; its second part originates in the areas around the stomodaeum and proctodaeum. Small annular zones of extremely brisk cell proliferation are formed here. Proliferation is particularly intensive in the proctodaeal region. The hystogenesis of the mesenteron in Lithobius is similar in general outline to that of Scolopendra dalmatica C. Koch. and Sc. cingulata Latr. (Heymons, 1901), but is markedly different from that of Rhysida, the eggs of which are rich in yolk. In this garden centipede the ultimate endoderm is formed by detachment of cells from a zone of proliferation at the rear end of the germinal band. These cells are in the nature of an epithelial plate, one side of which is adjacent to the vitelline endoderm. The vitelline endoderm does not take part in the formation of the epithelium of the mid intestine (Ivanov, 1940). It is interesting to note that in the Geophilidae, which are undoubtedly more closely akin to the Lithobiidae in their mode of life and in certain anatomical features than to certain other groups of chilopods, the mid intestine is also formed in the postembryonic period from the yolk cells by direct transition of the vitelline endoderm into the ultimate endoderm (Sograff, 1883). Formation of the intestinal endoderm from the vitelline endoderm occurs in the ontogenesis of Symphyla (Tiegs, 1945) and the Pauropoda (Tiegs, 1947). Partial formation of the intestinal endoderm from the yolk cells also occurs in the Thysanura (Sharov, 1953) and the Odonata (Tschuproff, 1904), the second source being the ectodermal cells of the stomodaeum and proctodaeum.

Life over land is accompanied by constant moisture deficit. Those arthropods that adopted a terrestrial mode of existence therefore had to develop adaptations to retain moisture. In this connection we shall examine certain morphophysiological adaptations. Thus, it is known that the initial aquatic forms of arthropods did not have Malpighian tubules. The antennal and maxillary glands (altered coelomoducts) served as excretory organs. On the transition to a terrestrial mode of existence the nephridial organs were replaced by Malpighian tubules. The development of Malpighian tubules was a phylogenetic reaction of the intestine to transition to a terrestrial mode of existence (Dogyel', 1938; Beklemishev, 1952). The hind intestine also developed at the same time as the Malpighian tubules appeared. In aquatic arthropods the hind intestine is usually short and restricted to the anal segment, and may sometimes be absent. In the initial aquatic arthropods the main function of the hind intestine was excretion of the feces. It was only after the appearance of the Malpighian tubules that its structure became considerably more complex and its functions were extended to include the resorption of water (Eidmann, 1922; Wigglesworth, 1932), i.e., water from the excretions that enter the hind intestine from the Malpighian tubules and water from the feces that is extracted in the hind intestine. Thus, the fact that the hind intestine resorbs water explains why the Malpighian tubules discharge into it and not externally, as do the coelomoducts. In this connection the occurrence of cryptonephridia (i.e., intimate contact between the ends of the Malpighian tubules and the walls of the hind intestine), which is to be found in terrestrial beetles (Haltica, Galerucella) and is absent from water beetles (Donacia)

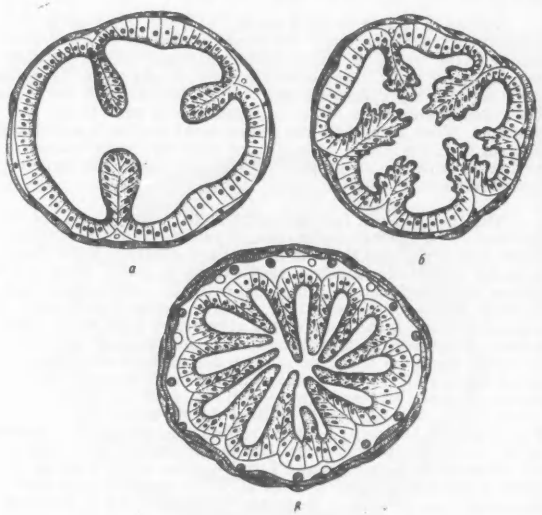

Fig. 6 - Comparison of the extent of the inner surface of the hind intestine in various of the Chilopoda. a - Geophilus proximus Koch; b - Lithobius forficatus L.; c - Cryptops punctatus Koch (Balbiani, 1890).

(Shvanvich, 1949), is of interest.

The replacement of the nephridia by Malpighian tubules should undoubtedly be seen as an adaptation to life over open land (Gilyarov, 1959). If one compares the structure of the hind intestine in animals from regions with different levels of moisture, one obtains an interesting morphological sequence that demonstrates the evolution of the hind intestine in the Opisthogoneata in the light of its newly-acquired function of water absorption (Fig. 6). Thus, in Geophilidae, that are true geobionts living in regions where the moisture supply is adequate, the surface of the hind intestine that absorbs water is still only slightly enlarged and consists of three smooth-walled folds along the inner surface of the intestine.

In Lithobiidae living in scrub, where the moisture content is unquestionably greater than in the soil, the hind intestine already has 4-6 longitudinal folds, the uneven surface of which increases their capacity for resorption. The hind intestine of garden centipedes, which normally live in the top-soil, has 14-16 longitudinal folds, which considerably increase the inner surface of the intestine. The development of the hind intestine has been most complex in insects, for which moisture retention is of great importance. In them it is long and consists of several sections. In addition to the longitudinal folds there are a number of apophyses and papillae projecting into the intestine. It is assumed (Wigglesworth, 1932) that the function of the rectal glands in the rear end of the intestine is active resorption of water from the feces. The hind intestine of all chilopods that have been studied, and of many insects, is richly tracheated. There is a large tracheal trunk from the last pair of stigmata to the hind intestine in chilopods. I consider it possible that these tracheae may be respiratory and may also regulate the amount of water in the organism; surplus water is apparently evaporated through them.

Thus the example of the development and evolution of the water-resorptive function of the hind intestine in the Atelocerata on transition to a terrestrial mode of existence is a good illustration of the principle of the extension of functions developed by Plate (1939).

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NEW GENERA AND SPECIES OF LEAF-HOPPERS (AUCHENORRHYNCHA, JASSIDAE) FROM THE USSR

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The article contains descriptions of new genera and species collected by the Kazakh multi-purpose biological expedition in Central Kazakhstan, and also of certain other new genera and species from European Russia and Central Asia. The types and paratypes of the new species and all materials referred to in the paper are to be found in the collection of the Zoological Institute of the USSR Academy of Sciences.

DIACRA EMELJANOV, gen. n.

Body rugulose, quite short. Head short, approximately as broad as the pronotum. Vertex without eyes 2-3 times broader than its length; the anterior margin protruding slightly forward or almost parallel to the posterior margin. In almost all species there is a transverse groove along the anterior margin of the vertex, which is usually slightly concave. The posterior margin of the vertex is slightly concave, almost straight; the eyes project far back and lie laterad of the pronotum. The face is fairly extended. The frontoclypeal area is approximately twice as long as it is wide; the sides, which are almost parallel in the upper half taper noticeably to the anteclypeus in the lower half. The anteclypeus is large, 2-3 times as long as its width, broadening slightly from the frontoclypeal area to the center; there is a groove of varying depth at the apex, which protrudes far beyond the limits of the face, so that the adjacent margins of the genae are concave. The lora are extended, with quite elongated apices, somewhat narrower than the anteclypeus; their inner margins border on the frontoclypeal area for slightly less than half their extent. There is no groove between the inner margins of the eyes and the bases of the antennae. The pronotum is transverse, only 1/3-1/2 as long behind the eyes as wide across the middle, its posterior margin almost straight, with a slight concavity in the middle, the sides without carinae, merging smoothly with the prothorax and diverging caudad; the anterior margin protuberant in the middle, almost straight, quite steeply curved initially at the sides but becoming concave behind the eyes. The scutellum is extremely small and only 1/10th - 1/15th the width of the pronotum. The tegmina are leathery and greatly shortened, so that almost all the abdomen is uncovered; they are truncated with rounded edges apically and touch the body at the sides with their costal rims to the underside of the body. Venation is barely discernible or quite indiscernible and there is no claval suture. 1 +2 spines on the upper surfaces of the hind tibiae, the proximal spine often being closely adjacent to the distal pair. The abdomen is conically tapered apically, short in the male and quite long in the female owing to the large pygofer and the long ovipositor. The female pygofer has no macrochaetae and occupies approximately 2/3rds the length of the abdomen below; the ovipositor extends quite prominently beyond the pygofer.

The species are pale brown or green and slightly opalescent, and sometimes have a waxy down on the integuments. Markins are mainly found on the face and abdomen. Brown transverse stripes on the frontoclypeal area are discontinued in the middle to leave a light upwardly tapering triangular area. The abdominal tergites are often dark brown with light spots forming longitudinal rows on the abdomen; there are two rows of spots adjacent to the center line on each side of the upper abdomen and two rows of especially large spots along the lateral edge and a further row between these pairs of rows; on the last tergites the spots are usually fewer in number owing to coalescence and reduction, and are less regular, so that the rows merge.

The male pygofer has a small dorsal groove, which may be almost absent, the lobes are rounded and without macrochaetae and project far beyond the anal plates, where their lower edges come close together or interlock. The anal tube is wide and short and projects slightly out of the pygofer. The genital clasper is large and lateral and has a more protruding apex. The genital plates are without macrochaetae and of varied form, their inner margins interlock or are gaping, the apices smoothly or sharply curved or obliquely truncated and the outer edges concave or convex. The distal portions of the styli are sickle-shaped or sometimes spoon-shaped and dilated. The connective is Y-shaped. The aedeagus is broad and short with a greatly reduced trunk and consists mainly of the sickle-curved lateral walls terminating in 1 or 2 projections. The gonopore is very broad and lies between membranous formations.

Type of the genus — Diacra convexa Em., sp.n.

This genus is quite clearly distinct from others, even from the isolated Eremophlepsius Zachv., 1924, which is similar in the structure of the genitalia and which also has a short aedeagus with sickle-shaped lateral walls and a gonopore lying between soft formations.

Diacra convexa Emeljanov, sp. n. (Figs. 12-14).

The insect is green and opalescent. The vertex is protruding, with only a weak groove in place of a carina, half as long again in the middle as at the eyes. Anteclypeus set off by a broad shallow groove. Pronotum behind eyes 1/5th as long as in the middle. Scutellum narrow with acute-angled apex. Tegmina with indistinctly elevated veins. Genital plates triangular, joined and with straight outer margins and sharply rounded apices. Length: ♂ 2.2-2.4 mm, ♀ 2.5-2.7 mm.

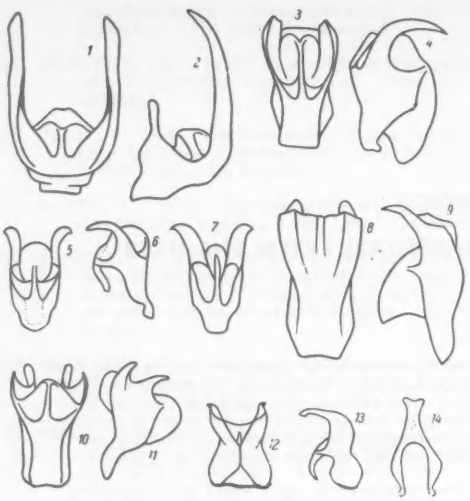
Material. Many males and females 40 km south of Zhan-Ark in the Karaganda region, 13 July-Aug. 1959 (holotype and allotype); Karasay, Dzhambul region, 16 July 1960 (Yemel'yanov); Bet Pak Dala, Kogashik, 9 July 1959 (Asanova).

On Anabasis salsa and A. ramosissima.

Diacra rugosa Emeljanov, sp. n. (Figs. 5, 6).

Vertex approximately 1 1/2 times longer in the middle than at the eyes. Groove of the anteclypeus wide, rectangular. Pronotum behind the eyes approximately 1/5th as long as in the middle. Scutellum very small and broad. Tegmina with indistinctly elevated veins. Genital plates divergent, with greatly rounded apices. Length: ♂ 2.6-3 mm, ♀ 3.7-4 mm.

Material. Many males and females, Uzbekistan, Termez, 1 August 1929.



Figs. 1 - 14.- 1, 2 - Diacra majuscula, gen.n., sp.n. (1 - aedeagus from behind, 2 - aedeagus laterally); 3, 4 - D. canescens, sp.n. (3 - aedeagus from above, 4 - aedeagus laterally); 5, 6 - D. rugosa, sp.n. (5 - aedeagus from above, 6 - aedeagus laterally); 7 - D. spuria, sp.n. aedeagus from above; 8, 9 - D. costata, sp.n. (8 - aedeagus from above, 9 - aedeagus laterally); 10, 11 - D. incana, sp.n. (10 - aedeagus from above, 11 - aedeagus laterally); 12, 13, 14 - D. convexa, sp.n. (12 - aedeagus from above, 13 - aedeagus laterally, 14 - connective).

Diacra spuria Emeljanov, sp. n. (Fig. 7).

Vertex approximately 1 1/2-2 times longer in middle than at eyes. Groove of anteclypeus narrow. Pronotum behind the eyes approximately 2/5th as long as in the middle. Scutellum broad, its apex a right angle. Tegmina with indistinctly elevated veins. Length: ♂ 2.3 mm, ♀ 4.1 mm.

Material. 1 ♂, 1 ♀, Uzbekistan, Shirabad, 2 July and 27 May 1912 (Kirichenko).

Diacra canescens Emeljanov, sp. n. (Figs. 3, 4).

Whole insect covered with waxy down. Vertex scarcely longer in the middle than at the eyes. Pronotum approximately 1/2 as wide behind the eyes as in the middle. Scutellum narrow with the apex acute. Tegmina with indistinctly elevated veins. Genital plates triangular, slightly divergent, with slightly concave outer edges. Length: ♂ 3.4 mm, ♀ 4.2 mm.

Material. 3 ♂♂ (holotype and paratypes), 1 ♀, Turkmenia, Imam-Baba on the Murgab (Kozhanchikov).

Diacra costata Emeljanov, sp. n. (Figs. 8, 9).

Vertex approximately 1 1/2 times longer in the middle than at the eyes. Pronotum behind the eyes 1/3 as long as in the middle. Scutellum broad with the apex right-angled. Tegmina with elevated veins. Genital plates short and semicircular. Length: ♂ 3.1 mm, ♀ 4-4.3 mm.

Material. Tadzhikistan: 1 ♂ (holotype, Koyp'-yaztau near Kabadian, 25 June 1934. 4 ♀♀, Ayvadzh on the Pyandzh, 16-17 June 1936 (Gussakovskiy).

Diacra majuscula Emeljanov, sp. n. (Figs. 1, 2).

Vertex in the middle approximately 1 1/2 times longer than at the eyes. Groove of anteclypeus narrow. Pronotum behind the eyes approximately 2/5ths as long as in the middle. Scutellum transverse with the apex acute, almost a right angle. Tegmina with indistinctly elevated veins. Genital plates triangular, slightly divergent apically, outer edges concave. Length: ♂ 3.5 mm, ♀ 4.4-4.7 mm.

Material. 1 ♂, 3 ♀♀, Kirgizia, Fergana, survey point at Tokhtaus on the road to Chatkal, 24 September 1929 (Umnov).

Diacra incana Emeljanov, sp. n. (Figs. 10, 11).

The whole insect covered with a thick waxy down. Vertex short, only slightly longer in the middle than at the eyes. Groove of anteclypeus narrow. Pronotum behind eyes only one half as long as in middle. Scutellum narrow, with apex acute. Tegmina smooth. Genital plates triangular with contiguous inner margins, narrowly rounded apices, slightly convex external margins, and with a dark spot near the base. Length: ♂ 3.5 mm, ♀ 4.5-4.8 mm.

Material. Kazakhstan, the Kyzyl Kum desert, Karachakuduk well, 1 ♂ (holotype), 25 June 1912, Barlybbaykuduk well, 2 ♀♀, 21 June 1912 (Zarudnyy).

Key for Species Recognition of the Genus Diacra Em., Gen. N.

1 (2). Lateral blade of the trunk of the aedeagus terminating in two curved projections..... D. incana Em., sp.n.

2 (1). Lateral blade of the trunk of the aedeagus terminating in one curved projection.

3 (4). Base of aedeagus the broadest part..... .....D. convexa Em., sp. n.

4 (3). Base of aedeagus relatively narrow, narrower than the distance between the apices of the lateral blades of the trunk.

5 (6). Posterior side of lateral blades of aedeagus slightly curved basally..... D. costata Em., sp. n.

6 (5). Posterior side of lateral blades of aedeagus smoothly convex.

7 (8). Projections of lateral blades of trunk of aedeagus very long, almost twice as long as the trunk itself..... .....D. majuscula Em., sp. n.

8 (7). Projections of lateral blades of trunk of aedeagus no longer than the trunk itself.

9 (12). Projections of lateral blades of trunk of aedeagus with divergent apices.

10 (11). Projections of lateral blades of trunk of aedeagus fairly thick and separated by their own width..... ..... D. spuria Em., sp. n.

11 (10). Projections of lateral blades of trunk of aedeagus noticeably narrower and more widely placed, so that they are 3-4 times their own width apart..... ..... D. rugosa Em., sp. n.

12 (9). Projections of lateral blades of trunk of aedeagus with parallel or divergent apices.

13 (14). Projections of lateral blades of trunk of aedeagus with approximately parallel apices..... ..... D. canescens Em., sp. n.

14 (13). Projections of lateral blades of trunk of aedeagus with greatly diverging apices...D. caesia Dlab. in litt.

MEGALOPSIUS EMELJANOV, gen. n.

Very similar in external appearance to species of the subgenus Symphyrrhoea Em. of the genus Goniagnathus. Head similar in structure but noticeably broader than the pronotum, and the frontoclypeal area more convex and projecting out of the plane of the face. Seen from the side the face is also greatly convex, so that its lower half is almost parallel to the dorsal surface of the body, while in species of the genus Goniagnathus Fieb. the

face is only slightly convex and inclined at an angle to the dorsal surface of the body. The outer parts of the lora below lie in the same plane, behind which part of the anteclypeus and the lora extend backwards, in a semicircle. The form of the anteclypeus, the frontoclypeal area and the lorum is the same as in the genus Goniagnathus. The pits of the antennae are deeper than in Goniagnathus. The vertex is approximately twice as long in the middle as at the eyes and very broad; its anterior margin is obtusely protuberant with a very gently curving apex. The pronotum is transverse, slightly more than 3 times as broad as it is long and of the same form as in the subgenus Symphyrrhoea. Long winged, tegmina longer than the abdomen. Apical spines on femora: 1 +1 +2.

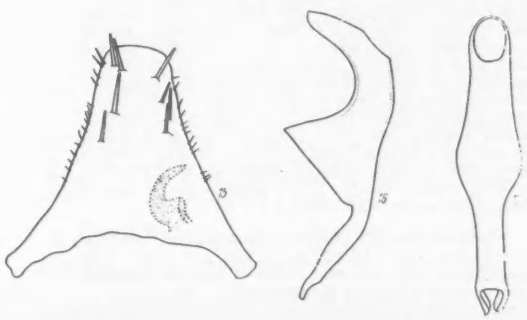
The pygofer of the male is quite long, slightly compressed at the sides and almost without a dorsal groove. The posterior margin of the lobes of the pygofer is straight, and slightly inclined so that the lobes are slightly contracted downwards; there is a row of large macrochaetae along the posterior margin and the lower margins of the lobes are in contact. The genital plate (united genital plates and genital clasper as in the genus Goniagnathus) is quite long, tapering to a transversely truncated apex and with slightly concave lateral margins. Anal tube entirely concealed in the pygofer. Two longitudinal rows of four chaetae on the apical half of the genital plate. Connective united with base of aedeagus; aedeagus simple, arcuate, cylindrical, slightly broadened basally and with a thick trunk; gonopore very large, slightly subapical to the dorsal side of the trunk.

Type of genus — Megalopsius oshanini Emeljanov, sp. n.

This genus is close to the genus Goniagnathus, but clearly distinguished from it by a whole series of characters: highly convex lower margins of the genae, spines on hind tibiae 1 +1 +2 and not 1 +2 +2, as in Goniagnathus, simple sickle-shaped apices of styli, greatly elongated genital plates, simple form of aedeagus, etc.

Megalopsius oshanini Emeljanov, sp. n. (Figs. 15-17).

All integuments highly lustrous, pale yellow with greenish-blue tinge. Head completely without markings. The females have 2 longitudinal vermilion spots with uneven edges in the middle of the pronotum and two more or less transverse spots on the sides at the posterior margin; in more highly pigmented specimens there are 4 indistinct longitudinal bands and the sides of the pronotum are vermilion; in less highly pigmented specimens this pattern is absent. Vermilion pattern on the tegmina in the form of indistinct oblique bands that merge with each other, leaving a free area around the costal margin and spaces at the cross-veins and the apices of the tegmina; the apices of the tegmina darkened. The red pattern is little developed or absent in the males. In the female the posterior margin of the last sternite is obtusely protuberant, with a gently rounded apex, the pygofer has sparse setae and vermilion spots that run into each other. Length: ♂ 4.2-4.5 mm; ♀ 4.6-5.0 mm.



Figs. 15 - 17. - 15, 16, 17 - Megalopsius oshanini, gen.n., sp.n. (15 - genital plate from below with apex of stylus indicated, 16 - aedeagus laterally, 17 - aedeagus from above).

Material. 5 ♂♂, 13 ♀♀ (holotype and paratypes), Farab, 16-18 June 1905 (V. Oshanin).

PHLEPSIDIUS EMELJANOV, gen. n.

Body slender. Head approximately of same width as pronotum. Vertex pentagonal with gently rounded apex and anteriorly diverging eyes which are very little wider than long. Ocelli large touching compound eyes. Face somewhat extended. Frontoclypeal area approximately twice as long as wide, lateral margins slightly convex in the lower part and slightly concave opposite the bases of the antennae. Anteclypeus half as wide as long, widening apically. Approximately half the inner edge of the lorum bordering on the anteclypeus. Eyes recessed opposite the bases of the antennae. Pronotum with convexly curved anterior margin, short posteriorly diverging lateral margins and trapezoidally protruding posterior margin slightly concave in the middle. Tegmina long, apices of clavi almost reaching the apex of the abdomen. M-Cu absent. Apical spines on hind tibiae 1 +2 +2.

Pygofer with deep round groove, lobes of pygofer with a vertical uneven row of macrochaetae at the base and hairs below, tapering to a smoothly rounded apex; a projection on the upper edge, the tip of which points backwards. Anal tube small and apically tapering. Genital clasper triangular and transverse. Genital plates with transversely truncated wide apices which merge smoothly with straight lateral margins bearing 1 row of macrochaetae. Connective short and broad, II-shaped. Base of aedeagus flat, with a pair of flattened cariniform projections. Slender curved trunk of aedeagus with small apical gonopore emerging from the base near its apical edge.

Type of genus — Phlepsidius desertorum Em., sp. n.

This genus is to some extent close to the genus Phlepsius Fieb., but differs both in external morphology (head only slightly narrower than pronotum, sides of pronotum only slightly divergent caudad, elytra without subsidiary veins and without M-Cu) and in the structure of the genitalia (genital plates with broadly truncated apices, connective II-shaped; apophyses at the base of the aedeagus).

Phlepsidius desertorum Emeljanov, sp. n. (Figs. 18-21).

Vertex dark brown with a pair of indistinct light spots near the posterior margin. Face light, with a dirty yellow tinge. Traces of dark brown lateral bands in the frontoclypeal area; imperceptible darkening of the genae beneath the antennae. Pronotum dark brown with light spotting, the larger dots at the anterior margin. Scutellum dark brown, darker in front of than behind the groove, two dirty white spots at the anterior margin, lateral angles dirty white, 4 dark brown spots of the same size immediately behind these spots; a larger dirty white spot on each side above the groove beneath the dark spots on the lateral margins and dark brown spots beneath the groove also on the lateral margins; apex of scutellum dirty white. Tegmina transparent with dark brown venation; indistinct dark brown spots on the cross-vein extending into the cell (as in the genus Anoplotettix Rib.); some cells also sometimes with light brown spots; apices of elytra shaded brown. Thorax light with a dirty yellow tinge, sutures darkened and with infrequent indistinct dark spots. Legs light with dark spots at the bases of the setae. Abdomen dark brown beneath with light margins on sternites. Terminal sternite of female light brown, its posterior margin protruding at an acute angle and apically rounded. Pygofer of female light brown and densely covered with macrochaetae.

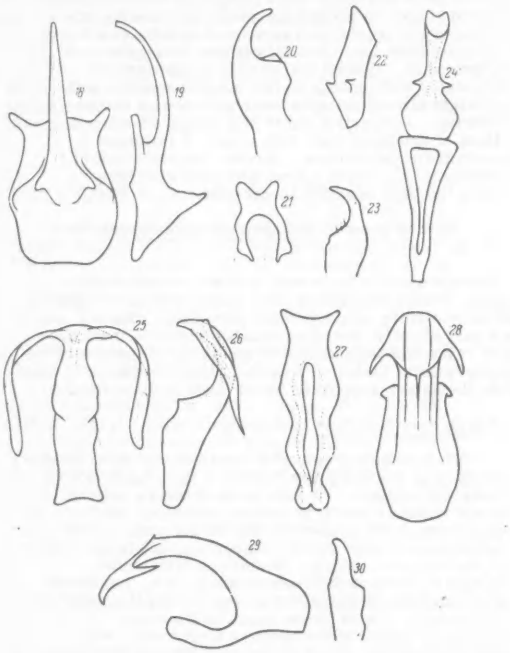
Length: ♂ 4.4-4.7 mm, ♀ 4.5 mm.

Material. 40 km south of Zhan-Ark in the

Karaganda region, July-August 1959, holotype and paratypes (Yemel'yanov, Loginova). On various salt bush shrubs: Atriplex cana, Suaeda physophora, etc.

PEDARIUM EMELJANOV, gen. n.

Body shortish, slightly depressed dorsoventrally. Vertex pentagonal with forwardly divergent ocular margins and an almost right-angled, not very broadly curving anterior margin. Frontoclypeal area approximately twice as broad as long, lateral margins straight, slightly diverging upwards, slightly concave opposite the bases of the antennae, strongly convex in front of the anteclypeus and tapering. Anteclypeus rectangular, its width approximately three quarters its length. Lora as wide as the anteclypeus, their inner edges bordering on the anteclypeus for approximately two thirds of their extent. Eyes recessed opposite the bases of the antennae. Proboscis slender, slightly longer than the anteclypeus. Pronotum broad, slightly wider than the head and a little shorter than the vertex; its anterior margin convex, its lateral margins with no carinae, quite long and slightly divergent caudad, its posterior margin almost straight with two slight protuberances separated by a depression. Scutellum small, less than one fourth as wide as pronotum. Tegmina shortened, dense and smooth, lying fairly flat so that their costal margins diverge noticeably backwards; apices widely rounded. M-Cu present. Apical spines on hind tibiae 1 +2 +2.



Figs. 18 - 30. 18, 19, 20, 21 - Phlepsidius desertorum gen.n., sp.n. (18 - aedeagus from above, 19 - aedeagus laterally, 20 - apex of stylus, 21 - connective); 22, 23, 24 - Agapelus aurantiacus Fieb. (22 - aedeagus laterally, 23 - apex of stylus, 24 - aedeagus from above and connective); 25, 26 - Pedarium ruderale, gen.n., sp.n. (25 - aedeagus from above, 26 - aedeagus laterally); 27, 28, 29, 30 - Pararguskerzhneri, gen.n., sp.n. (27 - connective, 28 - aedeagus from above, 29 - aedeagus laterally, 30 - apex of aedeagus).

Pygofer of male short, broad, strongly tapering to the anal tube, with a shallow, broad dorsal groove, slightly dorsoventrally depressed, its sides with a longitudinal carina, beneath which there is a somewhat oblique horizontal row of macrochaetae. Lobes of pygofer with apices projecting backwards at an acute angle and externally protruding; a long spine extending along the lower edge of the lobes from the inside to the apex. Anal tube short, broad and strongly tapering apically. Genital clasper transverse, semicircular. Genital plates triangular, meeting with narrow rounded apices and almost straight outer edges carrying 1 row of macrochaetae. Stylus of same structure as in the genus Circulifer Zachv. Connective Y-shaped, slender. Aedeagus similar in structure to that of the genus Circulifer. Only the lower part of the base developed, the trunk T-branched and the branches curving backwards and downwards with broadly rounded apices; gonopores subapical on the lower surface of the branches.

Type of genus — Pedarium ruderale Em., sp. n.

This genus is very closely allied to the genus Circulifer, but differs in external morphological details: transverse pronotum with long sides without carinae, shortened slightly flattened tegmina, structure and chaetotaxy of the pygofer and the depressed branches of the trunk of the aedeagus, and the slit-like subapical rather than apical gonopores.

Pedarium ruderale Emeljanov, sp. n. (Figs. 25, 26).

Light, almost white, with a slight brownish gray tinge. Fore wing with pair of fairly widely spaced black spots at anterior margin, 4 brown spots in a transverse row behind these and a pair of doubled longitudinal dashes on the sides near the posterior margin. Apically on the frontoclypeal area there is a large irregular black spot with an indentation on the upper edge. Black spots at the bases of the antennae often joined by an indistinct band of black specks that sometimes merge. Pronotum with very indistinct brownish markings, and 6 brown spots grouped in pairs to form a transverse row, the middle pair being slightly forward. Tegmina with brown-tinged veins and an indefinite oblique area of dark speckles in the middle, extending backwards and outwards from the scutellum. Two black spots on the sides of the last tergite and a few more small spots in a transverse row. The female has two black spots in subapical depressions on the sides of the pygofer.

Length: ♂ 2.2-2.4 mm, ♀ 2.4-2.7 mm.

Material. Many males and females, Chu, Dzhambul region, 14-15 July 1960 (Yemel'yanov, Kerzhner). 1 ♀, Iliysk 23 May 1959 (Mityayev). On weedy areas in the vicinity of Chu, very plentiful on wormwood.

AGAPELUS EMELJANOV, gen. n. (Figs. 22-24)

Slender. Vertex slightly longer than broad, pentagonal, with approximately parallel ocular margins, anterior margin acute-angled, with a rather narrowly rounded apex. Posterior margin of head smoothly curved upwards and quite shallowly grooved. Transition from vertex to face quite abrupt and curved. Frontoclypeal area pentagonal, tapering to anteclypeus, approximately one and one half times as long as it is broad. Apically tapering anteclypeus approximately one and one half times as long as it is broad. Lora small and with their margins bordering on the anteclypeus for approximately three quarters of their length. Eyes recessed opposite the bases of the antennae. Prontoum slightly more than twice as wide as it is long, its anterior margin evenly convex, lateral margins quite long, without carinae, posterior margin protruding trapezoidally. M-Cu present on the tegmina. Apical spines on hind tibiae 1 +2 +2.

Pygofer small, with a right-angled narrow dorsal groove extending slightly more than one third of its length seen from above. Lobes of pygofer rounded and covered with long macrochaetae. Anal tube slightly tapering apically, one and one half times as long as it is broad. Genital clasper transverse and semicircular. Genital plates shorter than lobes of pygofer, contiguous, with the concave outer margins carrying a row of long macrochaetae and giving way smoothly to straight, fairly wide truncated apices, as

in the genus Palus Del. Sleesm. Styli large and of normal shape, as in Palus, with coarse sickle-shaped apices. Connective in the form of a loop. Aedeagus small, with poorly developed base and thick cylindrical trunk, gonopore broad and apical.

Type of genus — Deltocephalus aurantiacus Fieb.

Similar to the genus Palus Ded. Sleesm., from which it differs in the absence of a sclerotized plate over the base of the aedeagus and in the form of the aedeagus, and to the genus Sorhoanus Rib., from which it differs greatly in the form of the aedeagus and the genital plates.

PANTALLUS EMELJANOV, gen. n.

Similar to the genus Psammotettix Hpt, in which it has been included by a number of authors (Ribaut, 1952; Linnavuori, 1953; Dlabola, 1955), but differs noticeably in the external appearance of the more rounded and smoothly curving head, and in having slightly flattened tegmina diverging caudad over the costae, etc. It also differs from the genus Psammotettix in having a strongly transverse genital clasper with a fairly smooth, arched, posterior margin, whereas Psammotettix species have a less transverse or non-transverse clasper that is clearly trapezoidal in form. The genital plates are longer than in Psammotettix, apically straight and not obliquely truncated, and the transition from the truncated posterior margin to the lateral margin is smooth and not abrupt. The dorsal wall of the pygofer is more sclerotized at the anterior margin than in Psammotettix. The lobes of the pygofer carry macrochaetae in an uneven horizontal row near the upper edge, whereas they are not arranged in any order in Psammotettix.

Type of genus — Deltocephalus alboniger Leth., the only species of the genus.

PARARGUS EMELJANOV, gen. n.

Vertex pentagonal, approximately as long as broad, the anterior margin obtuse-angled with a rounded apex. Frontoclypeal area almost one and three quarters longer than its breadth, sides almost parallel in the upper half and noticeably diverging towards the anteclypeus in the lower half. Anteclypeus rectangular, twice as long as it is broad. Lora quite large, their outer margins bordering on the anteclypeus for approximately two thirds of their length. Eyes recessed opposite the bases of the antennae. Pronotum almost three times as wide as long, anterior margin strongly convex and smoothly rounded, lateral margins short, without carinae, a wide narrow groove in the middle of the posterior margin, which is more prominent at the sides. Tegmina with quite numerous supernumerary cross-veins. Apical spines on hind tibiae 1 +2 +2.

Pygofer short with large oval dorsal groove. Lobes of pygofer with setae, their posterior and lower margins forming a single arc, the upper posterior angle with an upward-directed projection and the upper margin straight. Anal tube large, slightly tapering apically, approximately as long as broad. Genital clasper transverse, trapezoidal, with a very short posterior margin. Genital plates fairly long, slightly more than twice as long as the clasper behind the suture, meeting with slightly concave outer edges bearing a row of macrochaetae, and separate narrowly rounded apices. Stylus narrow and small apically, bent inwards and not outwards, as is usual. Connective loop-shaped. Aedeagus with a well developed base and an arched trunk, which is slightly depressed behind and extends outwards from the lower part of the base. A large subapical gonopore; and a pair of strongly reflexed projections lateral to the gonopore on the posterior side of the trunk.

Type of genus — Parargus kerzhneri Em., sp. n.

Parargus kerzhneri Emeljanov, sp. n. (Figs. 27-30).

An insect with brown to black markings on a dirty white ground; vertex, pronotum and scutellum orange tinged. Four small brown spots at the anterior margin of the vertex, with a pair of transverse, more or less rectangular spots behind them near the middle, forming a band which is interrupted in the middle; outer spots on the anterior margin of the vertex normally merged with these spots. Four indistinct longitudinal whitish brown bands at the posterior margin of the vertex. Six longitudinal brown bands on the pronotum, giving way to spots at the anterior margin; lateral bands slightly narrower and darker than the others. Veins on tegmina light, cells fringed with brown mottling set slightly away from the veins.

Black markings on the head are the sutures, the space beneath the eyes and the antennae and that above the antennae, the center line of the anteclypeus and the upper parts of the lora. In addition, the frontoclypeal area has black transverse bands that merge and form a wide longitudinal band along the center line divided lengthways by a more or less discontinuous light line. The underparts are black and the sutures lighter in places. The legs have black spots and longitudinal bands.

Length: ♂ 2.6-2.7 mm, ♀ 2.7-2.9 mm.

Material. Many males and females, Akmolinsk region, Kokshetau (low hill district), August 1957 (Yemel'yanov); Karaganda region, 40 km south of Zhan-Ark, August-September 1959 and 1960, holotype ♂, allotype (Yemel'yanov, Kerzhner). On couch grass (Agropyron repens and A. cristatum).

PHLEBIASTES EMELJANOV, gen. n.

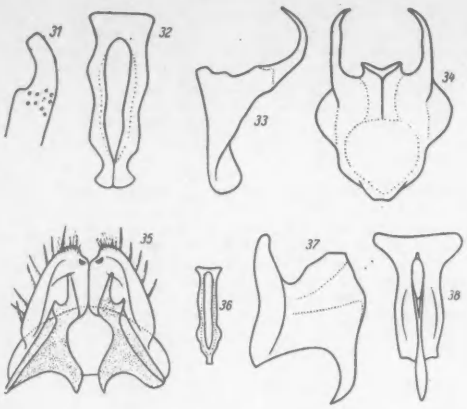
Head noticeably broader than pronotum. Vertex pentagonal, approximately as long as wide, anterior margin obtuse-angled with a quite narrow rounded apex. Frontoclypeal area quite narrow, upper two thirds parallel-sided, tapering evenly below. Anteclypeus rectangular, approximately twice as long as broad and quite large. Lora small, their inner margins bordering on the anteclypeus for approximately two thirds of their length. Borders of genae beneath lora quite broad. Rims of eyes recessed opposite bases of antennae. Pronotum slightly more than twice as broad as long, its anterior margin highly and evenly convex, the sides short and without a carina, the posterior margin with two bulges separated by a less pronounced groove. Tegmina well developed, with supernumary cross-veins in places on the corium and clavus. Apical spines on hind tibiae 1 +2 +2.

Pygofer short, with a broad, shallow dorsal groove which, nevertheless, almost reaches the posterior margin of the 8th tergite. Lobes of pygofer covered with strong macrochaetae, fairly long, tapering to rounded apices and drawing together at the lower margins. Anal tube short and very broad, dorsally depressed, very strongly tapering apically, where it is one quarter to one third as wide as at base. Genital clasper triangular with narrowly rounded apex. Genital plates extended, contiguous, twice as long as the clasper beyond the suture, apices separately narrowly rounded, outer edges concave, bearing a row of long macrochaetae. Connective loop-shaped. Stylus with a broad base and truncated apex terminating in a curved swelling. Aedeagus with a broad base, from which a pair of fairly long, widely spaced, backwardly curving unci arise. There is a very short trunk with a broad triangular gonopore between the bases of these unci.

Type of genus — Phlebiastes elymi Em., sp. n.

Phlebiastes elymi Emeljanov, sp. n. (Figs. 31-34).

Variegated with black and brown markings on a light grayish yellow ground. On the vertex: four whitish brown indistinct spots on the anterior margin, a pair of transverse, light brown, more or less rectangular spots near the middle, that seem to form a band broken in the middle, and 2 dark horseshoe-shaped spots convexly curved backwards behind them; the last four spots may be arranged in pairs. Four indistinct longitudinal bands on the pronotum, which has brown sides. Scutellum pale with a pair of dark spots at the anterior margin. Tegmina with veins light, and in places even white, and cells widely fringed with dark brown or black; alternate light and



Figs. 31 - 38. 31, 32, 33, 34 - Phlebiastes elymi, gen.n., sp.n. (31 - apex of stylus, 32 - connective, 33 - aedeagus laterally, 34 - aedeagus from above); 35, 36, 37, 38 - Tiaratus caricis, gen.n., sp.n., (35 - genital plates and styli from above, 36 - connective, 37 - aedeagus laterally, 38 - aedeagus from above).

dark spots in the cells along the costal margin; the basal one fourth of the costal margin light and fringed with brown, the second one fourth pale white with an almost square dark brown spot behind followed by an elongated pale spot and, finally, a further round brown spot immediately in front of the apical cells.

Facial sutures broadly darkened: broadly delineated above and below the antennae and beneath the eyes; anteclypeus above with a single indistinct black spot. Dark brown transverse merging bands on the frontoclypeal area; they merge along its center line in the upper one third into a longitudinal broad band that branches below into two parallel bands separated by a light band which meets a transverse white band at the lower edge of the frontoclypeal area to form an upturned T-shaped marking. Thorax and abdomen, black, margins of the sclerites light. Legs with more or less developed dark spots and longitudinal bands; brown spots at the bases of the setae of the hind tibiae.

Length: ♂ 2.6-2.8 mm; ♀ 2.7-3.0 mm.

Material. Many males and females, 40 km south of Zhan-Ark, Karaganda region, July-August 1959 and 1960, holotype ♂ (Yemel'yanov, Kerzhner). On Elymus angustus.

TIARATUS EMELJANOV, gen. n.

Close to the genus Diplocolenus Rib., from which it cannot be distinguished by external morphological characters. Vertex without eyes pentagonal, approximately as long as broad, eyes slightly divergent anteriorly, apex narrowly rounded. Frontoclypeal area pentagonal with straight sides tapering quite strongly to the anteclypeus, approximately one and one half times longer than its breadth. Lora small, their inner margins bordering on the anteclypeus almost throughout their extent. Eyes recessed opposite the bases of the antennae. Pronotum also of normal structure: anterior margin smoothly concave, posterior margin slightly convex in the middle and strongly concave laterally, lateral margins without carinae but very long.

Groove of male pygofer right-angled and shallow, lobes of pygofer simple and rounded, with a profusion of setae that are mainly short and almost cover the lobe. Anal tube cylindrical, almost twice as wide as long. Genital clasper transverse, semi-circular. Genital plates with apically convergent, concave outer margins bearing one row of macrochaetae and with broadly rounded apices. There is a groove, as in the genus Diplocolenus, near the point at which the genital plates engage, within their dorsal margins; opposite the groove on the outer surface of the genital plates there is a chitinous projection. Styli large and angular with fairly long straight apices. Connective loop-shaped, protruding and narrow. Base of aedeagus large and thickened; the short, greatly laterally compressed trunk arising from its lower half and with a large hooked protuberance at the apex on the dorsal side. Gonopore apical, longitudinally extended.

Type of genus — Tiaratus caricis Emeljanov, sp. n.

Despite its great similarity to the genus Diplocolenus, it differs from that genus strongly in the structure of the aedeagus, which is very broad and short and does not have paired apophyses, but an unpaired, very large evagination which has no homologues in the genus Diplocolenus, and also in the position of the grooves on the genital plates and in the chaetotaxy of the lobes of the pygofer.

Tiaratus caricis Emeljanov, sp. n. (Figs. 35-38).

All integuments dirty greenish yellow. Two black triangular spots, quite widely spaced, on the vertex, with two additional rectangular spots behind, in from the ocelli, and behind them two more, less strongly developed spots, normally forming the pattern . There is an indistinct dark spot between the compound eyes and the ocellus. A scarcely perceptible transverse pattern on the frontoclypeal area, the triangular region along the center line normally remaining free. Four indistinct brownish longitudinal bands on the pronotum, the inner of which are continued as rows of spots to the vertex. Tegmina semi-transparent with whitish veins, slightly longer than the abdomen in the male and slightly shorter in the female. Dorsal surface of abdomen black except for the terminal (8th) tergite and the sides of the other tergites. Outer edges of sternites and center of basal sternite sometimes darkened, as is also the middle of the genital sternite in the female.

Length: ♂ 2.6-2.9 mm; ♀ 3.4-3.5 mm.

Material: 8 ♂♂, 5 ♀♀ (holotype, allotype and paratypes); 40 km south of Zhan-Ark, Karaganda region, 15 June 1959, (Yemel'yanov). On carex sp. prope uralensis.

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THE EGGS OF HEMIPTERA-HETEROPTERA: VI - PENTATOMOIDEA, 2. PENTATOMIDAE AND PLATASPIDAE

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Of the Pentatomoidea families, the one with the largest number of species is the true Pentatomidae. As the author mentioned in her last communication, the ages of this family were first described in the second half of the nineteenth century and the beginning of the twentieth. All the descriptions of that period are summarized by Butler (1923). Since the 1920s papers on the eggs of various Pentatomidae have appeared every three to five years, but there have been only a few descriptions, mainly of certain species of the tribe Pentatomini, and to this day the literature contains no more than a score or so of accounts of true Pentatomidae eggs. Many papers emphasize the ecological characteristics of the egg stage (where and how the eggs are laid, how long the embryo takes to develop and so forth) rather than the morphological.

There is no need to discuss the detailed morphology of Pentatomidae eggs in this paper, since their main differences from the eggs of other Pentatomoidea were examined in a previous paper (Puchkova, 1959) in a treatment of the superfamily. Nearly all representatives of the true Pentatomidae lay their eggs openly on various parts of plants, although these parts are not invariably used as food. The majority, appropriately to their mode of life, lay their eggs on herbaceous plants; a few (Pitedia, Pentatoma, Arma and others) do so on trees or shrubs. Certain species lay their eggs among vegetable waste or in the top layer of sand (Menaccarus). They generally arrange their eggs in groups of one or two, but not more than four, single-layer rows; if the substratum does not offer a fairly sizeable flat surface the orderly arrangement is destroyed and the eggs clump together haphazardly (Graphosoma, Carpocoris and others). Some species lay one, two or three eggs at a time on the leaves (Sciocoris sulcatus, S. cursitans etc.) or flowers (Vilpianus, Stagonomus) of food or other plants.

True Pentatomidae eggs are found in nature from May until August. In most species the height of the egg-laying season is in June; in many Podopinae oviposition is fairly intensive in July but it falls off in that month in the case of the Pentatominae and Asopinae. In species found in the south of the USSR which produce two or three generations a year (Dolycoris, Carpocoris, Eurydema, Bagrada) and in those which lay their eggs in the fall (Pentatoma rufipes, Picromerus bidens) the egg-laying seasons are, of course, different.

The chorion of Pentatomidae eggs is often covered with little spines or "villi" of some kind, in a reticulate arrangement, and is sometimes colored; less frequently it is completely smooth and comparatively rarely it is transparent. Unlike those of many other Hemiptera, the eggs take their color from that of the chorion itself and acquire their normal pigmentation one to three hours after laying; subsequent changes in color, if any, are negligible. The dark coloration of the secretion encasing the eggs of many Asopinae appears at roughly the same time; only in Picromerus does complete coloration not set in until the second or third day.

The micropylar processes are often comspicuous and are columnar or clavate; in most Asopinae they are long and curved as illustrated in Fig. 6. In a number of species, however, they are barely noticeable and cannot be distinguished without specially treating the chorion. The operculum boundary is invariably easy to see and the line of rupture of the chorion is smooth and closed within the ring of micropylar processes. In extremely rare cases this line is uneven and intersects the ring of micropylar processes (Menaccarus), and then the operculum boundary in eggs still containing the embryo is hard to make out.

The egg-burster is triangular and transparent and furnished with two black or black-brown keels forming a T; the crests are more rarely colorless, or not colored throughout but only at the intersection of the keels, where the apex or "tooth" of the egg-burster is situated. In a number of cases there are distinct differences between one species and another in regard to the contour of the small caps of the egg-burster and the shape of the crests on them, as well as in the ratio of pigmented to colorless parts (Figs. 35 and 41); but sometimes the egg-bursters of closely similar species belonging to the same genus are identical (for example, species of the genera Aelia, Neottiglossa and Eurydema). These exceptions, however, in no way diminish the importance of the egg-burster in species diagnosis and the precise determination of generic placement.

In the fauna of the European part of the USSR the true Pentatomidae are represented by only three subfamilies. In two of these (Podopinae and Pentatominae) the eggs do not differ sharply, while even the characteristic eggs of the Asopinae species can easily be included in the same identification table.

Identification Table for Eggs of Pentatomidae

1 (12). Micropylar processes prominent, long, curviform, tapering gradually towards the tip (Figs. 2 and 8), or else comparatively short and very thick (Figs. 3 and 4). Eggs often uniformly black or brown.

2 (3). 26-29 micropylar processes. Chorion a dirty black, without reticular sculpture. Length 1.14 mm, width 0.90 mm (Fig. 1). 25 to 80 or more eggs per oviposition. Eggs are laid from the second half of August onwards and remain throughout the winter..... .....Picromerus bidens L.

3 (2). Fewer than a score of micropylar processes.

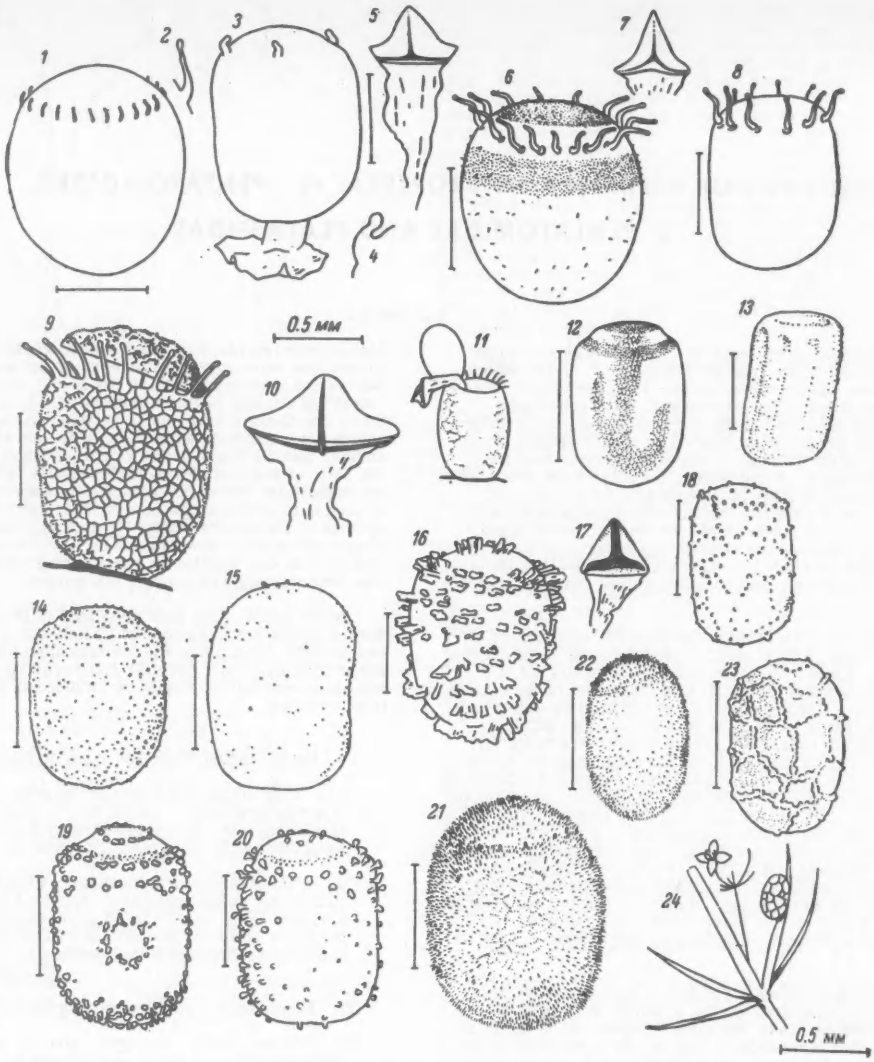
4 (5). 5-8 very thick micropylar processes (Fig. 4). Eggs often attached to a thick pedicle formed of the female's secretions. Chorion pitch black, with a thick alveolate structure not found in the slightly constricted middle of the egg. Length 1.05 mm, width 0.77 mm (Fig. 3). Oviposition occurs, from early May into June; there are 4-5 rows containing 68-96 eggs..... Jalla dumosa L.

5 (4). Micropylar processes shaped differently; more than 10 of them present (Figs. 7-9).

6 (7). Eggs yellowish, with a wide, dark gray band at base, another near top below the ring of micropyles and one on the operculum. Chorion has a slight metallic glint, no reticular outline but short black spines scattered irregularly on the darkened parts. Often 12-14 micropylar processes. Length 1.04 mm, width 0.88 mm (Fig. 6). Eggs arranged in staggered rows on the leaves of various trees and shrubs, preferably on alder infested with alder-leaf beetle. The number of eggs per oviposition ranges from 8-12 to 30-50. Oviposition in May and up to the end of June..... Arma custos F.

7 (6). Eggs dark, sometimes with scattered lighter areas. Chorion has reticular sculpturing and may be either bare or completely villous.

8 (9). Chorion coarsely honeycombed and villous. 10-17 micropylar processes. Length 1.30 mm, width 1.10 mm (Fig. 9). Eggs in two rows, usually 14 per oviposition, on needles and leaves of various trees and shrubs, from late May to early June. Troilus luridus F.



Figs. 1 - 24. 1 - Picromerus bidens L.; 2 - micropyl or process of P. bidens; 3 - Jalla dumosa L.; 4 - micropyl or process of J. dumosa; 5 - egg-burster of J. dumosa; 6 - Arma custos F.; 7 - egg-burster of A. custos; 8 - Zicrons coerulea L.; 9 - Troilus luridus F. (after Kehler); 10 - egg-burster of T. luridus; 11 - opened egg of T. luridus; 12 - Tarisa pallescens Jak.; 13 - Crypsinus angustatus Baer.; 14 - Trigonosoma halophilum Jak.; 15 - Tr. philalyssum Kir.; 16 - Tr. trigonum Kryn.; 17 - egg-burster of Tr. trigonum; 18 - Leprosoma incospicuum Baer.; 19 - Sternodontus obtusus Mls. R.; 20 - Ancyrosoma leucogrammes Gmel.; 21 - Graphosoma lineatum L.; 22 - Derula flavoguttata Mls. R.; 23 - Vilpianus galii Wolff; 24 - egg of V. galii on Galium leaf.

9 (8). Chorion completely smooth, without hairs.

10 (11). Eggs brown, with a coppery tint. Chorion with distinct reticular sculpturing. About 12 micropylar processes. Length 1.25, width 0.70 mm. Eggs laid in several rows, 8-14 at a time, on leaves of osiers and other shrubs in late May and June. Eysarcoris punctatus L.

11 (10). Black, sometimes with coarse, irregularly arranged, light patches; chorion covered with fine network, visible only under lateral illumination. 14-15 micropylar processes. Eggs 1.05 mm long, 0.76 mm wide (Fig. 8). Laid in several rows, usually 30-70 at a time, on the leaves of various plants infested with flea beetle larvae (Halticini), in May and until July... Zicrona coerulea L.

12 (1). Micropylar processes, slender, of a different shape from (1), sometimes indistinguishable. Eggs are not black but sometimes have a black outline.

13 (92). No bands on lateral surface of eggs, which are more or less of one color except that the hairs and lirae of the chorion and a spot on the operculum are sometimes of a different color. The chorionic cells are invariably larger than 0.1-0.3 mm except when the lirae bordering them are villous.

14 (33). Chorion bare, without spines or hairs discernible under a 20 x magnifier.

15 (22). Chorion without obvious reticular sculpturing, smooth or rough.

16 (19). Micropylar processes barely or not at all distinguishable, impossible to count.

17 (18). Eggs mat, roughly cylindrical, the middle part a little constricted but wide and the ends very blunt; more or less brownish; chorion rough (Fig. 62) (See also couplet 101)..... Codophila varia F.

18 (17). Eggs very shiny, true ovoid in shape, yellowish. Length 0.92 mm, width 0.74 mm (Fig. 25). Laid one at a time among vegetable waste and in top layer of sand in June..... Menaccarus arenicola Scholtz

19 (16). Micropylar processes distinct. Eggs laid in groups on plant leaves.

20 (21). Smaller, 17-18 micropylar processes. Eggs yellowish. 0.99 mm long, 0.75 mm wide (Fig. 44). Laid usually in two rows of 4-12 eggs on various parts of Stachys silvatica, less frequently on other plants in the same biotopes, in June and July ..... Stollia venustissima Schrnk.

21 (20). Larger. 23-28 micropylar processes. Eggs greenish, 1.26 mm long, 1.14 mm wide (Fig. 72). Laid in staggered rows, mostly 14-28 at a time, on leaves of linden, oak and other trees in the second half of August and in September; the larvae over-winter..... Pentatoma rufipes L.

22 (15). Chorion with distinct polygonal reticular sculpturing, easily distinguishable under 20 x magnifier.

23 (24). Eggs green, 0.75 mm long, 0.54 mm wide (Fig. 12); found on saltworts Suaeda, Petrosimonia. Eggs laid in two rows of about 10 each in late June and July..... Tarisa pallescens Jak.

24 (23). Eggs colored differently, found on other plants.

25 (28). Micropylar processes completely indistinguishable.

26 (27). Pale yellow, cylindrical with falttened operculum. Chorionic network fine, with small cells. Length 0.71 mm, width 0.40 mm (Fig. 13). Eggs laid in two rows of 6-8 or fewer on various parts of Lepidium ruderale from mid-May to July..... Crypsinus angustatus Baer.

27 (26). Pale yellow, oval, slightly thickened above. Chorion covered with coarse honeycombing of whitish uneven cells with discontinuous lines in places and small cells between them. Length 0.81 mm, width 0.54 mm (Fig. 23). Laid in groups of 1-2 or up to 12 at a time (in which case they are arranged in two regular rows) in the top layer of Galium ruthenicum (Fig. 24). Oviposition in June-July ..... Vilpianus galii Wolff.

28 (25). Micropylar processes distinct even when short, at least on individual parts of the micropylar ring.

29 (32). About 10-12 very short micropylar processes. Eggs yellowish.

30 (31). Eggs more prolate; 12 whitish micropylar processes, more easily discernible than in 31. Chorionic network fine, discernible only under strong magnification. Length 1.10 mm, width 0.60 mm. Laid in two longitudinal rows of 8 eggs each on various parts of plants in May and June..... Podops inuncta F.

31 (30). Eggs shorter; about 10 micropylar processes, all the same color as the chorion and hard to distinguish. Chorion densely honeycombed with cells separated by broad margins barely rising above its surface. Length 0.81 mm, width 0.58 mm (Fig. 28). Laid in irregular row of 5-8 eggs on different parts of plants, preferably Scabiosa and Knautia, in June-July..... Sciocoris macrocephalus Fieb.

32 (29). About 28-30 longer, whitish micropylar processes. Eggs gray, sometimes with a gold tint, covered with a thick network of small hexagonal cells. Length 1.40 mm, width 1.15 mm. Laid in two rows of 14 on leaves of trees and shrubs, preferably linden, poplar and hazelnut, from the second half of May until July..... Rhaphigaster nebulosa Poda.

33 (14). Chorion more or less closely covered with little spines or villi easily discernible under 20 X magnifier.

34 (43). Operculum with a ring of more or less long villi; a second ring usually situated on body of egg, encircling operculum border on the outside. No reticular chorionic sculpturing. Micropylar processes indistinguishable.

35 (36). Eggs dark gray with two concentric rings of warty, fungiform villi on lateral surface formed on the outside during oviposition. Light hairs reminiscent of the mold ring on rotten apples. Length of egg 1.05 mm, width 0.79 mm (Fig. 19). Laid 12 at a time in two rows along branches and rays of umbel, Trinia henningii from mid-June into July..... Sternodontus obtusus Mls. R.

36 (35). Lighter, with no trace of rings on lateral surface.

37 (42). Chorionic villi sturdy, lamellar or fungiform, widening towards the tip.

38 (39). Lamellar villi gathered into a thick crown at flat operculum border and on same plane as this border. Eggs yellow, cup-shaped. Length 1.13 mm, width 0.94 mm (Fig. 16). Laid 1-5 at a time, sometimes 12, in two rows on various parts of Nigella from late June until August..... Trigonosoma trigonum Kryn.

39 (38). Villi more or less fungiform, widening towards tip, not lamellar, and not forming a crown situated on same plane as operculum. Egg cylindrical, blunt and rounded at the ends.

40 (41). White and cream-colored, becoming slightly pink as embryo develops. On lateral surface villi form a coarse honeycomb pattern but on operculum they are grouped into a ring which is sometimes joined to the border of the operculum by radial lamellar villous processes. Length of egg 0.91 mm, width 0.62 mm (Fig. 18). Laid in two regular rows, sometimes 16 at a time, on different parts of Alyssum and on ground and vegetable waste near these plants in May and June..... Leprosoma inconspicuum Baer.

41 (40). Bluish-gray, becoming yellow as embryo develops. Villi on lateral surface occur haphazardly, while there are none at all on the operculum except in the region of the central ring. Length of egg 1.07 mm, width 0.68 mm (Fig. 20). Laid in 2 rows, often 12 at a time, on various parts of plants, especially Torilis leptophylla and Orlaya platycarpos, from June to August..... Ancyrosoma leucogrammes Gmel.

42 (37). Chorionic villi short and slender, somewhat larger and clavate at micropylar end, not forming a crown at mouth of egg, and arranged haphazardly except for a ring of sparse hairs on the operculum. The egg is whitish, mat, 1.10 mm long and 0.81 mm wide (Fig. 15). Laid in two regular rows of 12 each on leaves and stalks of Alyssum tortuosum and other species of the same genus from the end of May until July..... Trigonosoma philalyssum Kir.

43 (34). Operculum may be sculptured but never has a ring of villi in the middle; nor is there one on the body of the egg round the mouth. The villi are usually short; if long, they become sharper towards the tip and are situated on a network of lirae covering the chorion.

44 (61). Small villi or spines set haphazardly, no reticular sculpturing on chorion.

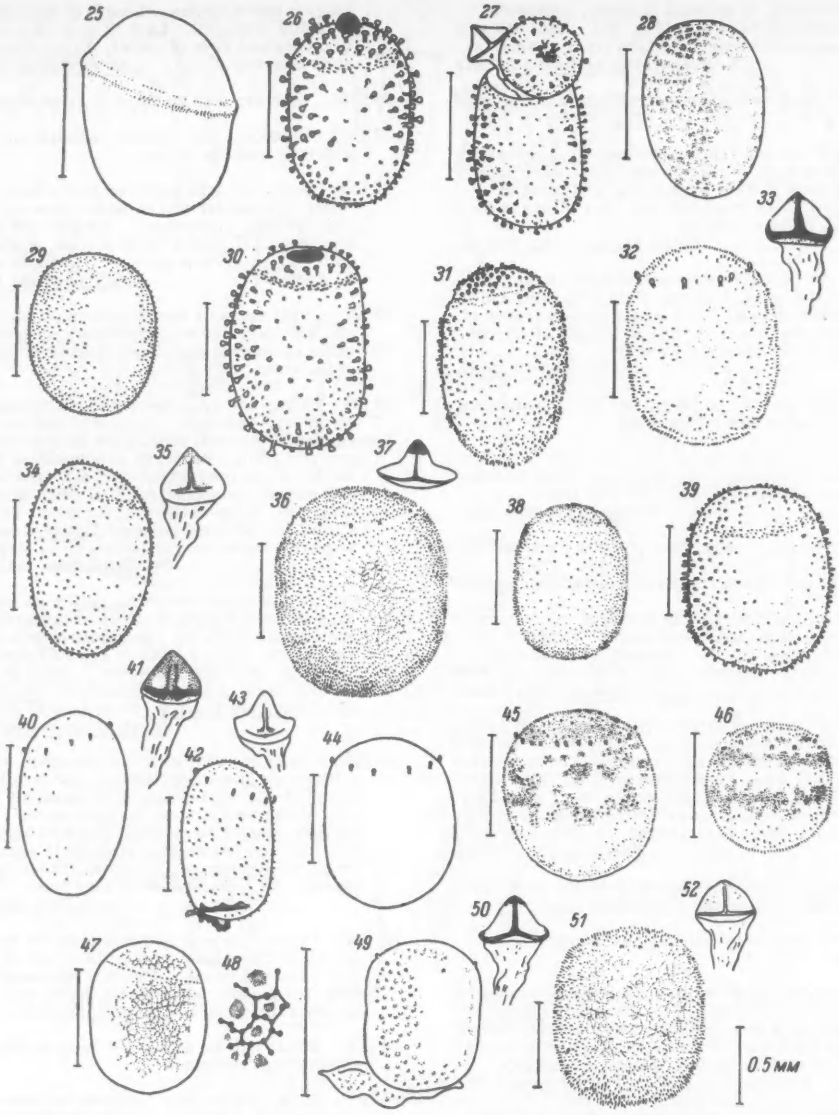
45 (50). A red patch in the center of the operculum. The eggs are laid, upright or, more rarely, on their sides, one or, less frequently, two or three at a time on different parts of plants or waste. Chorionic villi fairly long, not close-set. Micropylar processes cannot be distinguished.

46 (47). Patch on operculum formed of 8-10 more or less close-set columnar processes often joined together at the base. Chorionic villi close-set. Eggs a yellowish gray, 0.96 mm long and 0.64 mm wide (Fig. 26). Oviposition from May to August. A very common species..... Sciocoris cursitans Fieb.

47 (46). Patch on operculum only slightly raised above surface.

48 (49). Patch circular, nodular, red throughout. Chorionic villi clavate and nail-shaped. Eggs pale pink, 1.06 mm long and 0.82 mm wide, laid from May to August..... S. deltocephalus Fieb.

49 (48). Patch of irregularly circular shape, not solid but consisting of two or three, and not more than 7-8, clavate processes bent towards the center of the operculum and often not touching one another (Fig. 27). Rather cone-shaped hairs forming a crown, not close, round the mouth of the egg. Eggs grayish, 0.81 mm long and 0.61 mm wide. Oviposition in June and July.



Figs. 25 - 52. 25 - Menaccarus arenicola Scholtz; 26 - Sciocoris cursitans Fieb.; 27 - Sc. sulcatus Fieb.; 28 - Sc. macrocephalus Fieb.; 29 - Sc. homalonotus Fieb.; 30 - Sc. deltocephalus Fieb.; 31 - Sc. distinctus Fieb.; 32 - Dyroderus umbraculatus Wolff; 33 - egg-burster of D. umbraculatus; 34 - Stagonomus pusillus H.-S.; 35 - egg-burster of St. pusillus; 36 - Aelia acuminata L.; 37 - egg-burster of A. acuminata; 38 - A. klugi Hahn; 39 - A. virgata Klug; 40 - Stagonomus amoenus Brulle; 41 - egg-burster of St. amoenus; 42 - Stagonomus bipunctatus; 43 - egg-burster of St. bipunctatus; 44 - Stollia venustissima Schrnk.; 45 - St. aenea Scop.; 46 - St. inconspicua H.-S.; 47 - Neottiglossa leporina H.-S.; 48 - detail of chorionic sculpturing of N. leporina; 49 - Rubiconia intermedia Wolff; 50 - egg-burster of R. intermedia; 51 - Staria lunata Hahn; 52 - egg-burster of St. lunata.

Found only in the south of the USSR....S. sulcatus Fieb.

50 (45). No red spot in the center of the operculum.

51 (54). Chorion closely covered with hairs. Micropylar processes hard to distinguish.

52 (53). Villi long and whitish. 19-21 micropylar processes, thicker but not longer than the villi. Eggs yellowish and of true oval shape, 0.82 mm long and 0.61 mm wide (Fig. 22). Laid in several rows, 14 at a time, on various plants from the end of May until July. Derula flavoguttata Mls.R.

53 (52). Villi very short, of the same color as the chorion; micropylar processes still shorter, very small and barely discernible. Eggs grayish, oval, 0.80-0.97 mm long and 0.60-0.75 mm wide (Fig. 38), laid in one longitudinal row, usually 3-5 (but frequently 10) at a time, on the leaves of grain crops, usually in the lower part of the plant, from the second half of May until July..... Aelia klugi Hahn.

54 (51). Chorion has more or less sparse, sometimes very short (magnification up to 60) little spines or nail-like villi.

55 (56). Chorion covered with thick nail-like villi which are particularly obvious in the upper half of the egg. The

micropylar processes are longer than the villi but more slender and hard to discern. Eggs bright yellow, oval, 0.87 mm long and 0.62 mm wide (Fig. 34), set one, two or three at a time, upright or on their sides, on various species of the genus Ajuga, usually at the base of the flowers, in the second half of May and in June..... ..... Stagonomus pusillus H-S.

56 (55). Chorion has very short spines.

57 (60). Spines dark. Micropylar processes fairly easy to see.

58 (59). Oval; grayish. Spines very short, readily discernible only at end of egg under transmitted light; on the surface of the egg they look like stippling. 10-12 short micropylar processes, enlarged at the tips. Eggs are 0.92 mm long, 0.68 mm wide (Fig. 29), laid 2-6 at a time in two longitudinal rows on various parts of plants and vegetable waste from May to July..... .....Sciocoris homalonotus Fieb.

59 (58). Irregularly oval, widening in front, olive-green in color. Spines nodular, not giving the surface a stippled appearance, larger on operculum. Micropylar processes 12-14, usually 12, fairly long but slender, widening slightly and bent inwards at the tip. Length of egg 0.84 mm, width 0.51 mm (Fig. 42). 2-5 eggs laid at a time on various parts of plants. Oviposition has been observed at the end of June and in July..... ..... Stagonomus bipunctatus L.

60 (57). Light, very small spines on chorion, discernible only under 50-60 X magnification, and looking like frozen droplets. Micropylar processes clavate, readily distinguishable only at a particular angle of vision and difficult to count. Eggs irregularly oval, widening in front, grayish, 0.90 mm long and 0.57 mm wide (Fig. 40), laid upright on their sides, either one or two to four at a time, on flowers and other parts of species of the genus Salvia in June and July.....S. amoenus Brulle

61 (64). Chorion covered with reticular sculpturing. Villi form definite patterns, usually on lirae surrounding the cells of the network.

62 (65). Micropylar processes nodular, difficult or impossible to distinguish. Villi look like small loops and are situated on the lirae or at their intersections. Grayish-green or grayish, shaped like a short cylinder with round ends. Laid in two longitudinal rows on the ears of grain crops, preferably species of the genus Poa, in May and June.

63 (64). Micropylar processes no larger than the villi and very hard to distinguish. The eggs are generally in regular rows and are laid 10 at a time. Length 0.80 mm, width 0.62 mm.....Neotiglossa pussila Gmel.

64 (63). Micropylar processes barely larger than the villi, 9-12 in number, usually 12. Egg rows generally irregular; number of eggs ranging from 7 to 17. Length 0.78, width 0.59 mm (Fig. 47)..... N. leporina H-S.

65 (62). Micropylar processes columnar, longer and more easily discernible. Villi longer and not giving the lirae a knotty appearance. Eggs laid in several rows.

66 (71). Villi much shorter than micropylar processes.

67 (68). Eggs green. 29-35 micropylar processes, nearly five times longer than the short villi. Length 1.39 mm, width 1.05 mm (Fig. 53), laid usually 28 at a time on leaves of herbaceous and tree plants in May and June... ..... Palomena prasina L.

68 (67). Eggs not green. Not more than 17 micropylar processes, which are only twice as long as the hairs.

69 (70). Eggs pale gray of almost regular oval shape. Micropylar processes the same color as the villi and difficult to distinguish against the background of villi; there are about 10 of them. Length of egg about 1.05 mm, width 0.90 mm (Fig. 32). Laid in batches of 5-6 or up to 12 on Galium mollugo, in the upper part of the plant. Oviposition in May, June and July..... .....Dyroderes umbraculatus Wolff.

70 (69). Eggs yellowish, of short oval shape. 14-17, usually 15 micropylar processes, which are short, but thick, and enlarged towards the tip. Length of egg 0.93 mm, width 0.82 mm (Fig. 57). Laid 10-16 at a time on plant leaves in May-July..... ..... Holcostethus vernalis Wolff.

71 (66). Villi long — no shorter or only slightly shorter than the micropylar processes.

72 (89). Lirae of reticular chorionic sculpturing do not differ substantially in color from the chorion itself. Cells of network small (except C. lunulatus).

73 (74). Eggs laid one at a time. Micropylar processes masked with villi and difficult to distinguish. Villi columnar and cone-shaped, widening towards the tip. Eggs sky-bluish gray, acquiring a claret color as the embryo develops. Length 1.01 mm, width 0.67 mm (Fig. 31). Laid among vegetable waste and on various plants in the part nearest the ground, in May and June. ..... Sciocoris distinctus Fieb.

74 (73). Usually more than ten eggs per oviposition. Micropylar processes distinct.

75 (78). About 30 micropylar processes, thicker than the villi, but almost the same length and color as these. Villi fairly long (about 0.05 mm) and close-set. Eggs light yellowish, laid on various small single-layer umbels in several rows or in a clump, from mid-June into July.

76 (77). Micropylar processes slightly shorter than the villi and harder to distinguish. Eggs wider in front than behind; length 1.18 mm, width 0.98 mm. Usually laid 14 at a time. Common in the south of the USSR..... .....Graphosoma semipunctatum F.

77 (76). Micropylar processes longer than the villi and easier to see. Eggs of regular oval shape. Length 1.12 mm, width 0.91 mm (Fig. 21). Number of eggs per oviposition less constant, but often also 14. Common in central zone of USSR.....G. lineatum L.

78 (75). Not more than 20 micropylar processes. Villi short, about 0.02-0.03 mm.

79 (80). 12-14 micropylar processes. Cells of chorionic network larger, tips of villi brownish, darker than the pale yellowish background of the egg. Length of egg 0.99 mm, width 0.83 mm (Fig. 61). 25-30 eggs deposited at a time in 3-5 staggered rows on leaves of various plants in May-June and July-August (two generations in the south).....Carpocoris lunulatus Goeze.

80 (79). More than 16 micropylar processes. Chorionic network cells small and villi of the same color as the general background. Not more than 14 eggs in one oviposition.

81 (86). Eggs always laid in two regular rows, usually six to a row. Found on leaves of Gramineae from May to July.

82 (85). Villi fine and close-set. 18-22 micropylar processes. Eggs pale cream or cream in color.

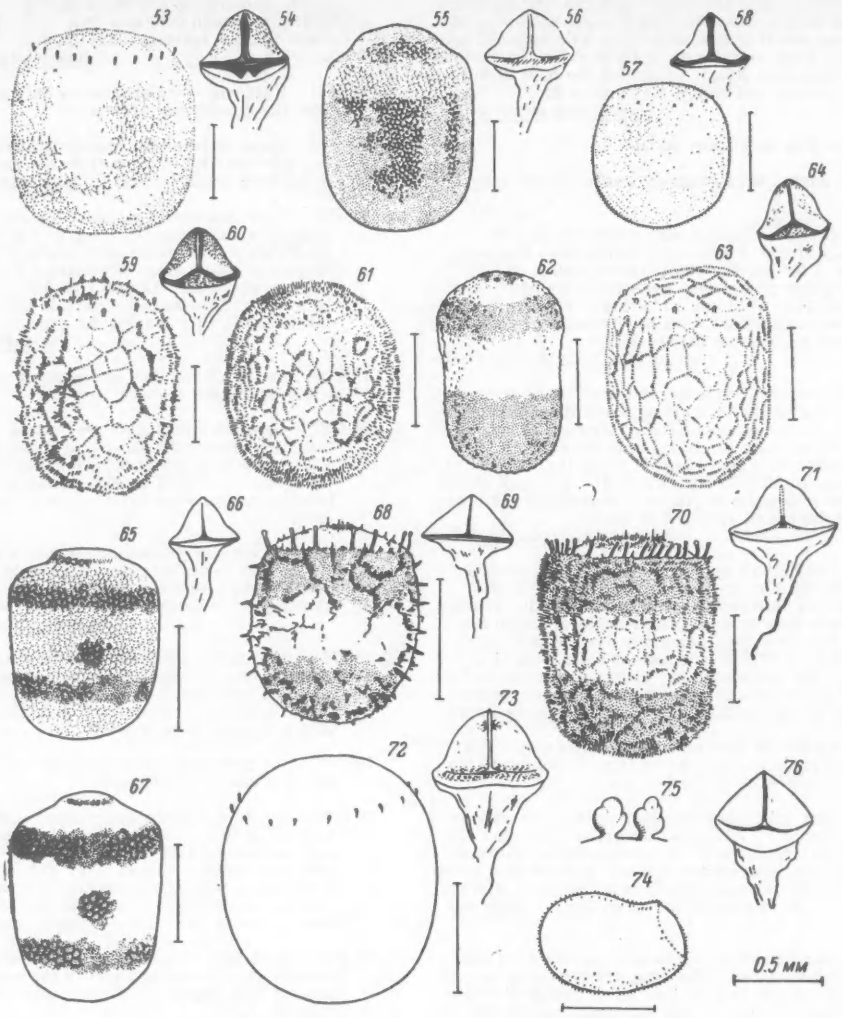
83 (84). Rod-shaped villi (which appear enlarged at the tips when magnified 50-60 times) very densely covering the surface of the chorion. 19-21 micropylar processes. Length of egg 0.92 mm, width 0.74 mm (Fig. 36)..... .....Aelia acuminata L.

84 (83). Villi distinctly enlarged in club shape toward the top and less densely distributed on the chorion. 18-22 micropylar processes. Length of egg 0.94 mm, width 0.71 mm.....Ae. rostrata Boh.

85 (82). Villi thick, shorter and several times sparser, columnar or nail-shaped. 16-19 micropylar processes. Eggs grayish yellow, 1.03 mm long and 0.79 mm wide (Fig. 39)..... A. virgata Klug.

86 (81). Eggs always laid in several staggered rows.

87 (88). Eggs creamy-white. 17-21 micropylar processes, irregularly clavate and slightly longer than the villi. Length of egg 0.79 mm, width 0.40 mm (Fig. 49). Usually 14 eggs per oviposition. Oviposition noted in June.....Rubiconia intermedia Wolff.



Figs. 53 - 76. 53 - Palomena prasina; 54 - egg-burster of P. prasina; 55 - Pitedia pinicola Mls.; 56 - egg-burster of P. pinicola; 57 - Holcostethus vernalis Wolff; 58 - egg-burster of H. vernalis; 59 - Carpocoris pudicus Poda; 60 - egg-burster of C. pudicus; 61 - C. lunulatus Goeze; 62 - Codophila varia F.; 63 - Dolycoris baccarum L.; 64 - egg-burster of D. baccarum; 65 - Eurydema oleracea; 66 - egg-burster of E. oleracea; 67 - E. festiva L. (= ornata L. non ventralis Kol.); 68 - Bagrada stolata Horv.; 69 - egg-burster of B. stolata; 70 - Piezodorus lituratus F.; 71 - egg-burster of P. lituratus; 72 - Pentatoma rufipes L.; 73 - egg-burster of P. rufipes L.; 74 - Coptosoma scutellatum Geoffr.; 75 - egg-burster of C. scutellatum.

88 (87). Eggs light yellowish. 20-23 micropylar processes, which look like whitish spots, thicker but no longer than the villi. Length of egg 1.04 mm, width 0.72 mm (Fig. 51); laid 10-12 at a time from June to August. . . . . Staria lunata Hahn.

89 (72). Lirae and the villi protruding from them much darker than the chorion, which shows up as light between them. Network cells large.

90 (91). 20-25 micropylar processes, usually 22 or just under that number. Chorion yellowish, lirae and villi dark brown. Villi longer. Length of egg 1.38 mm, width 1.04 mm (Fig. 59). Laid in 3-4 rows of 9-29 eggs each (usually 13-14) on various plants from May to August. . . . . Carpocoris pudicus Poda.

The eggs of C. fuscispinus Boh. do not appreciably differ from those of this species.

91 (90). 14-17 micropylar processes, usually 15. Chorion light yellow or cream-colored, lirae and villi cinnamon-brown. Villi half the length of those in 90. Length of egg 1.04 mm, width 0.79 mm (Fig. 63). Laid in several rows, usually 13-29 eggs at a time, on various plants from May to August . . . . . Dolycoris baccarum L.

92 (13). Eggs have alternating dark and light, more or less distinct, bands.

93 (100). Surface of chorion has villi or spines.

94 (99). Network on chorion formed of villous lirae. Micropylar processes fairly large and easy to count.

95 (98). Egg in the form of a short oval or spheroid, convex at anterior end, grayish-green with dark gray bands. Chorion with network cells small. Not more than 28 thin micropylar processes, usually fewer. Eggs much smaller.

96 (97). Eggs scarcely longer than those of 97. Wide ring

on operculum reaching its edges but diffused. Band on lateral surface of egg, formed by a series of irregular partially merged dark spots, appears even more diffuse than the operculum ring. 26-28 micropylar processes. Length of egg 0.82 - 0.88 mm, width 0.73 - 0.77 mm (Fig. 45). Eggs laid in two, sometimes irregular, rows. Number of eggs per oviposition varies, but is usually about 9-11. Oviposition in June and July. The species is connected mainly with labiate plants..... Stollia aenea Scop.

97 (96). Spheroidal, with a narrower dark ring on operculum and two slightly diffused, dark bands on lateral surface. 14-15 micropylar processes. Length of egg 0.62 mm, width 0.62 mm (Fig. 46). Laid 10-11 at a time in one irregular row on the ears of various Gramineae, particularly Glyceria aquatica, from May until July..... S. inconspicua H. -S.

98 (95). Egg in the shape of a short cylinder, oblate at the anterior end, dirty white in color with two grayish black bands on lateral surface and a ring on each end. Chorion covered with coarse-celled sculpturing. 29-35 micropylar processes, usually 32 or just under, not slender and fairly long. Length of egg 1.22 mm, width 0.96 mm (Fig. 70). Up to 29 laid at a time, more usually 11-19, in two rows on various parts of leguminous plants, especially Cytisus, Genista, Coronilla, Lotus, from end of May until July..... Piezodorus lituratus F.

99 (94). Chorionic network formed by a series of spines of different length, more easily distinguished against the dark-colored parts of the chorion. Micropylar processes long but slender and colorless and hard to count. Egg in the shape of a short cylinder with blunt rounded ends, milky white in color, with a dark gray base, wide annular band on lateral surface below operculum, and a ring on the operculum itself. Length of egg 0.82 mm, width 0.65 mm (Fig. 68). One or several (not more than 5-6 eggs laid at a time in a longitudinal row on various parts of plants of the genus Alyssum and on waste near these plants, from May to August. Bagrada stolata Horv.

100 (93). Surface of chorion free of villi or spines.

101 (102). Chorion without reticular structure but rough and covered with large irregular pits. Egg the shape of an irregular cylinder a little constricted at the middle; brownish, with a dark brown ring on the operculum, a wide annular band of the same color in the anterior part and a darker base; sometimes, however, these parts are hardly distinguishable in color from the rest of the chorion surface. Micropylar processes very short and impossible to count. Length of egg 1.7 mm, width 0.74 mm (Fig. 62). Oviposition in a single layer containing 7-8 rows of 33-34 or more (up to 50) eggs, in May-June and July-August (two generations)..... Codophila varia F.

102 (101). Chorion covered with a dense network of short, smooth (without villi) lirae forming almost perfect hexagonal cells.

103 (104). Eggs have clear black or gray markings, cylindrical shape, the anterior end in the form of a truncated cone with a slightly convex tip and flattened base (Figs. 65-67). Basal part of egg yellowish, with dark annular bands anteriorly and posteriorly, and spots on a central, light band between the dark bands. The basal flattened part of the operculum is light but there is a dark patch, or the remnants thereof, on its convex part. The operculum is bordered by a fillet of very slender, fairly long micropylar processes. The eggs are laid usually 12 at a time in two regular rows on various parts of cruciferous flowers..... Eggs of species of the genus Eurydema.

104 (103). Eggs have no distinct dark markings. A light band on upper third of egg more noticeable in developing eggs, whereas the empty shells seem to be all white and only with 30-50 magnification can it be seen that the cell area in this portion is lighter than the lirae, instead of the reverse, as on other parts of the egg. 15, or just under, short but fairly thick micropylar processes, which are nevertheless difficult to count. Eggs laid 14 at a time, in two rows, on pine needles in May-June... ..... Pitedia pinicola L.

Eggs of Plataspidae

The earliest descriptions of this peculiar and somewhat isolated family of Pentatomoidea did not appear until the 1930s. Southwood (1956), relying on these, gives the general characteristics of Plataspidae eggs, and referring to the similarity of the egg-bursters states that the family is close to the Pentatomidae. In fact, the egg-bursters are of Pentatomoidal shape, but this similarity is undoubtedly of the convergent kind and is due to the presence of a preformed earlier operculum boundary as in eggs of the Pentatomidae. The shape of the egg, the structure of the chorion and the micropylar processes of Plataspidae eggs are very peculiar, but the generic affinities of the family are more accurately expressed in certain structural details of the female genitalia than in the structure of the egg-burster and indicate a distant relationship between the Plataspidae, Scutelleridae and Cydnidae.

The sole representative of the Plataspidae found in the European part of the USSR is Coptosoma scutellatum Geoffr., which lays its eggs in a horizontal position and in a double-row herringbone arrangement, 4-12 at a time, on the leaves of lucerne, vetchlings and other pulses. There is one generation and the eggs are found in July. They are of rhopaloid shape (Figs. 74-76) but differ from Rhopalinae eggs in having numerous micropylar processes around the operculum; 3-4 micropylar processes on the lower side of the micropylar ring are situated on the operculum itself. The chorion is covered closely with a network of cells and short villi. The micropylar processes take fantastic shapes (Fig. 75) and are 29-32 in number. The egg is 0.86 mm long and 0.55 wide.

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TWO NEW SPECIES OF FLEA BEETLES (COLEOPTERA, CHRYSOMELIDAE, HALTICINAE) FROM TADZHIKISTAN

I. K. LOPATIN

1. Phyllotreta ustulata Lop., sp. nov.

Male. Small, elongated, slightly convex, shining, pitch-black; anterior and posterior edges of pronotum brown; elytra yellow, with brown humeral tubercles and a narrow, brown, lanceolate sutural border, of indeterminate boundaries, extending beyond the middle; first to fourth antennal segments yellow, tip of fifth dark brown, the rest pitch-black; femora brown, tibiae brown and yellow, the anterior and median tibiae being the lighter; tarsal claws darker.

The head is finely shagreened, with sparse, distinct punctures on the frons and a longitudinal fovea between the frontal tubercles. The antennae reach the middle of the elytra; the first segment is slightly curved and thickened towards the tip, the second is three-fourths as long as the first but of the same thickness, the third somewhat shorter and appreciably more slender than the second, the fourth the same length as the second and fifth and the sixth shorter than the third. The apical segment of the antenna is convex above, elongated at the tip into a short point and hollowed spoon-like below.

The pronotum is slightly convex, 1.4 times as wide as it is long, with almost straight sides and rounded obliquely at the anterior and posterior angles. The anterior setiparous pore is set at a distance slightly greater than its diameter from the anterior angle of the pronotum, its lateral edge being thickened; the pronotal disk is uneven and covered with shallow punctation, the punctures having a diameter equal to the spaces between them.

The elytra with their convex humeral tubercles are three and a half times longer than the pronotum; at the humeri they are noticeably wider than the pronotum, convex and with their greatest width beyond the middle. The elytral disc is covered with small, dense, shallow punctures which never form rows; from the humeri the sides are almost rectilinear, widening slightly for two-thirds of their length and then rounding slightly but only briefly; the tips have broad round notches and the sutural angles are rounded off.

The pygidium protrudes, is readily visible and shining, covered with dense, very small punctures and occasional short hairs.

The legs are thin. The hind tibiae are covered with fine setae on the inner side and with fine, short spines on the outer side; the spur of the hind tibia is short and curved; the hind claws are long, the first tarsal segment the longest and slightly curved, with the pretarsus somewhat shorter than the first segment and equal to the second and third together. The length is 1.3 mm and the breadth at the humeri 0.5 mm.

Female. Somewhat larger, with the last antennal segment normal instead of spoon-shaped and with a still more protruberant pygidium.

Found in S. Tadzhikistan, Kara-Tau ridge, 15 km from Kirovobad, in the pistachio belt. Feeds on saltwort. 25 specimens found on 16 May 1958 (I. Lopatin). Types deposited in the USSR Academy of Sciences Zoological Institute collection in Leningrad, syntypes in the Tadzhik Academy of Sciences Institute of Zoology and Parasitology at Stalinabad.

Individual variation takes the form of contraction of the pitch-black and brown outline of the elytra, until there is no longer any trace of a sutural border. In the light-colored specimens the pronotum is brown or even brownish yellow at its base. In such specimens the first to sixth antennal segments are completely yellow.

The species is similar to Ph. turcmenica Wse, particularly the light-colored individuals of that species, but is well differentiated by its smaller size, the punctation of the head and, in particular, of the elytra (where the punctures nowhere form rows), and by the elytral outline.

2. Chaetocnema (s. str.) ljudmilae Lop., sp. nov.

Female. Fairly large, elongate-oval, reminiscent of the elongated species of Psylliodes in general body structure, mat-brilliant, metallic green with a slight gold-copper iridescence on pronotum. The tip and base of the first antennal segment, the whole of the second and third segments and the base of the fourth rusty brown; upper part of labium black; tibiae of all legs yellow-brown; apical tarsal segment and claw of hind leg are pitch-black and brown, femora black-green with metallic iridescence; anterior femora with rust-colored indeterminate spots dorsally and interiorly.

The head is convex, without frontal carina; a barely perceptible shagreening with continuous, equal-sized punctures, covers the frons and vertex; the punctures are shallow and everywhere smaller than the spaces between them; in the middle of the frons the punctures are sparser and the spaces between them wider; a line-like transverse depression passes between the antennal sockets; below this the punctation thickens — a particularly noticeable feature, because above the depression the frons has no punctures for a short distance. The supraocular lines are made up of merged punctures; the upper edge of the ocular sockets forms a short, sharp carina; the lower part of the clypeus and the gena are covered with extremely fine silvery hairs, the lower edge of the clypeus and the large labrum (especially the latter) by long hairs. The antennae are slightly longer than half the body length: the first segment is one and a half times as long as the second, its tip not reaching the middle of the eye, and thickens evenly towards the tip; the second segment is almost twice as long as its own width; the third is hardly longer than the fourth but both are perceptibly longer than the second and shorter than the first.

The pronotum is one and a half times wider than long and is convex, with a somewhat flattened disc and steeply receding sides. Punctation is even, except on the ventral edge, where the punctures become steadily smaller and finally disappear. The pronotal punctation is the same as that of the vertex except that it is slightly deeper on the sides, but the barely perceptible shagreened spaces are almost everywhere larger than the punctures. Viewed from the side, the lateral edge of the pronotum is almost straight but is somewhat tapered anteriorly in front of the anterior setiparous pore, which is separated from the ventral angles by a distance equal to twice its own diameter. The posterior setiparous pore is small and is situated almost exactly at the posterior angle. Viewed from above, the lateral edges of the pronotum are evenly rounded as far as the anterior setiparous pore, the anterior angles are obliquely sheared inwardly, with a projecting denticle in the place where the pore is situated; the posterior

angles are very short and protrude slightly outwards. The scutellum is small, apically rounded, slightly shiny and very slightly shagreened.

The elytra are long — three times the length of the pronotum and almost twice as long as they are wide, with convex humeral tubercles and very regular punctate furrows against a slightly shagreened background; the punctures in the rows are no larger than those on the pronotum and become somewhat smaller candad; the spaces between the rows of punctures are flat except on the sides, where they are slightly convex; the widest part of the elytra is in front of the middle, after which they gradually become perceptibly narrower; the tips are narrow, the sutular angles rounded off away from each other; the epipleura are wide but gradually narrow and are visible up to the actual tips of the elytra; a row of punctures runs along their lower edge from the base to the level of the first abdominal segment.

The pygidium is small and narrow, with a slight longitudinal depression in the middle and a convex apical edge, and is covered with small punctures and short hairs.

The hind tibia has a circular cleft in the apical part; the denticle of this joint is large and slightly obtuse-angled and is surrounded by long slender pili which protrude from the cleft as appreciably shorter, thicker processes, giving place to short setae behind the cleft; the inner side of the joint is covered with long, slender setae in the region of the cleft. The spur of the hind tibia is short. The first segment of the hind tarsus is longer than the claw segment and than the second and third segments together.

The length is 2. 9 mm, the width at the humeri 1.2 mm.

One specimen was found in S. Tadzhikistan, Parkhara district forest in Kzyl-Su delta, on 17 May 1958 (I. Lopatin). The type specimen has been deposited in the USSR Academy of Sciences Institute of Zoology, Leningrad.

The insect can be referred to the group Ch. psylloides Pic, but is clearly differentiated from it and from other species of the group by its very prolate, elongated-elliptical body, the perfectly regular punctate rows on the elytra and the smaller sparser punctures on the pronotum.

A NEW SPECIES AND TWO UNKNOWN MALES OF THE GENUS RHOPUS FÖRST. (HYMENOPTERA, ENCYRTIDAE), WITH A NOTE ON THE GENERIC CHARACTERISTICS OF DOLIPHOCERAS MERC. AND RHOPUS FÖRST

LIAO TING-HSI

Interesting parasitic Hymenoptera (Chalcidoidea), including specimens of a number of new species, were collected by the author and V. A. Tryapitsyn during a mission to Batumi in 1958. This paper describes the female of a new species of the genus Rhopus Först, and two male specimens belonging to this genus. The latter may represent other new species but one of them most probably belongs to the same species as the former. This question cannot be settled on the evidence available and we shall therefore designate the males by numbers. The insects were collected by mowing from a section of the Georgian laboratory for biological pest control in the Batumi area. Despite repeated searches the parasite hosts were not found. It can be assumed that, like other species of this genus, these insects live on mealybugs infesting grains.

Twenty-seven species of Rhopus Först. (Xanthoencyrtus Ashm.) are known in the world fauna; of these, thirteen are from Europe, seven from the Hawaian Islands, four from Australia, two from North America and one from southern Asia. Most of these have been described from the male, as the females are found very much more rarely.

The new species has been named after the well-known biological pest control expert, Ye. M. Stepanov.

The type specimens are in the USSR Academy of Sciences Institute of Zoology, Leningrad.

Rhopus stepanovi Liao, sp. n.

Female (Fig. 1). Body very flattened. Head prognathous. Occiput sharply margined. Vertex and frons wider than the longitudinal axis of the eye. Genae shorter than half the longitudinal axis of the eye. Distance from dorsal ocellus to orbit roughly equal to half an ocellus diameter. Antennae (Fig. 2) articulated to edge of mouth. Scape fusiform and almost as long as pedicel and first two funicular segments together. The pedicel is twice as long as its width and wider at the tip than the first funicular segment. The funicle thickens towards the tip. Its first segment is slightly longer than it is wide; the other segments are wider than they are long. The second segment is the same length as the third or slightly shorter; the fourth is the shortest, the fifth longer than the second but shorter than the first, the sixth the widest and the same length as the first or slightly longer. The club is oval and made up of two segments slightly wider than the funicle, the first of which is shorter than the second. The thorax is narrower than the head. The pronotum (Fig. 3) is divided by a longitudinal suture into two triangular sclerites, its dorsal edge being deeply indented in the middle. The mesontal scutum is transverse. The scutellum is shorter than the mesonotal scutum and rounded at the apex. The postphragma has a rounded tip and extends to the second visible tergite of the abdomen. The wings (Fig. 4) may be either developed or reduced: in the former case the forewings are longer than the abdomen, the disc is closely covered with hairs and the costal cell is narrow. The marginal vein is longer than the postmarginal. The fringe is very short. The spur of the middle tibia is slender and appreciably shorter than the first segment of the tarsus (Fig. 5). The abdomen is longer than the thorax. The pygostyles project forward to half the length of the abdomen. The exterior plate of the ovipositor (without apophysis) is twice as long as it is wide (Fig. 6).

The body is yellow, but the posterior edge of the scutellum, the anterior edge of the mesonotum, the club of the antennae, the basal half of the scape and the first three segments of the funicle are brown. The compound eyes are purplish black, the ocelli colorless. The wings are colorless, with brownish veins. The female is 0.9 - 1.2 mm long.

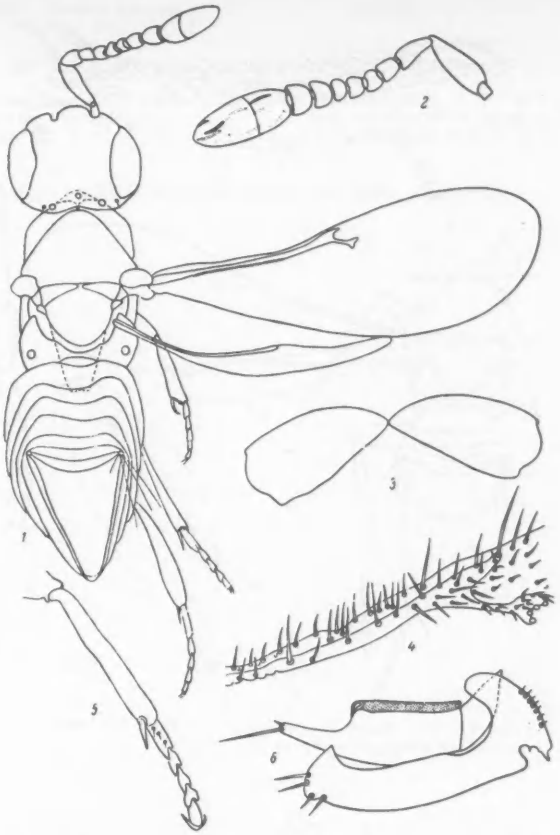
Material used: Kakhaberi, Batumi region, 17 May - 19 June 1958, 14 ♀♀ (Liao Ting-Hsi, V. Tryapitsyn). Holotype: total preparation no. 650.

The species resembles Rh. semiapterus (Merc.) (Spain, England) and Rh. fullawayi (Timb.) (Hawaii), from which it can be distinguished by the features tabulated below (♀♀):

Rh. semiapterus (Merc.)	Rh. fullawayi (Timb.)	Rh. stepanovi, sp. n.
Segments I-IV of funicle small, rounded or slightly transverse; VI longer and wider than the rest.	Segment I of funicle longer than its width and longer than the rest, which are wider than their length.	Segment I of funicle equal in length to VI or slightly shorter; VI wider than the rest.
Funicle tricolored: segments I-III black, IV brown, V-VI yellow. Scape and pedicel yellow.	Funicle of a uniform dark color. Scape and pedicel brown, apex of pedicel yellow.	Funicle bicolored: segments I-III brown, IV-VI yellow. Scape and pedicel yellow-brown, apex of pedicel yellowish.
Parasite of Ripersia sp. on Deschampsia caespitosa.	Parasite of Pseudococcus saccharifolii (Green).	Host unknown.

Rhopus sp. (1).

Male (Fig. 7). The head is almost prognathous. Width of vertex greater than distance between occipital carina and antennae. Compound eyes small, oval, covered with sparse, slender, light hairs. Ocelli in an obtuse-angled triangle; dorsal ocelli near occipital carina. Distance from dorsal ocelli to orbit of compound eyes less than the distance between ocelli. Genae equal to longitudinal axis of eye. Antennae (Fig. 8) articulated at level of lower edge of eyes. Scape somewhat flattened and almost equal in length to the pedicel together with the first segment of the funicle. The funicular segments are twice, two and a half or three times as long as their width, the first being longer than the next four and roughly equal to, or sometimes longer than the sixth; segments I-V have each one longitudinal sensillum; the last segment has seven to eleven scales on its lower surface and two sensilla. The club is not segmented and is lanceolate, almost equal to the two terminal segments of the funicle and furnished with four to six sensilla. The thorax is flat and narrower than the head. The pronotum is divided into two triangular sclerites. The mesonotal scutum and the scutellum are wider than they are long, the latter being rounded at apex and shorter than the former. The postphragma has a rounded tip and extends to the second visible abdominal tergite. The fore wings have narrow costal cells (Fig. 9). The marginal vein is almost punctiform and diverges from the wing edge; the postmarginal vein is thick and slightly more than half the length of the radius. The fringe is very short. The spur of the middle tibia is roughly equal to the first tarsal segment. The abdomen is shorter than the



Figs. 1 - 6. Rhopus stepanovi, sp. n.♀ 1 - female; 2 - antenna; 3 - pronotum; 4 - venation of forewing; 5 - tibia and tarsus of median leg; 6 - ovipositor.

head and thorax combined. The phallobase (Fig. 10) is twice or three times as long as it is wide and has two spines on the digital sclerites and two small hairs near the tip.

The body is brown, the head cinnamon-brown; the antennae are also cinnamon-brown, but lighter below. The edges of the pectus, the axillae, the sides of the mesothorax and the median segment are brown-black. The legs are brownish-yellow, the coxae and femora of the hind legs darker, the dorsal surface of the tibiae and the tarsi brownish. The abdomen is rust-colored and darker along dorsal ridge. The insect is 0.8 - 1.3 mm long.

Material used: Kakhaberi, Batumi region, 13 May - 2 July 1958, 20 ♂♂ (Liao Ting-Hsi, V. Tryapitsyn).

The male is rather like the male of Rh. semiapterus (Merc.), except that in the latter the scape is longer than the first two funicular segments, the postmarginal vein is hardly present and the body is almost black.

Rhopus sp. (2).

Male. The antennae (Fig. 11) are shorter than in the preceding species, and the scape is longer than the pedicel and first funicular segment combined. The funicular segments are shorter and wider, I-V being of almost identical length and roughly twice as long as they are wide, and VI being the longest, roughly two and a half times as long as wide. Each segment except II has one longitudinal sensillum; VI has six to nine scales on the lower surface. The club is somewhat longer than the last two funicular segments and has three or four sensilla. The phallus (Fig. 12) is somewhat shorter and thinner than in the preceding species and the phallobase roughly three times as long as it is wide.

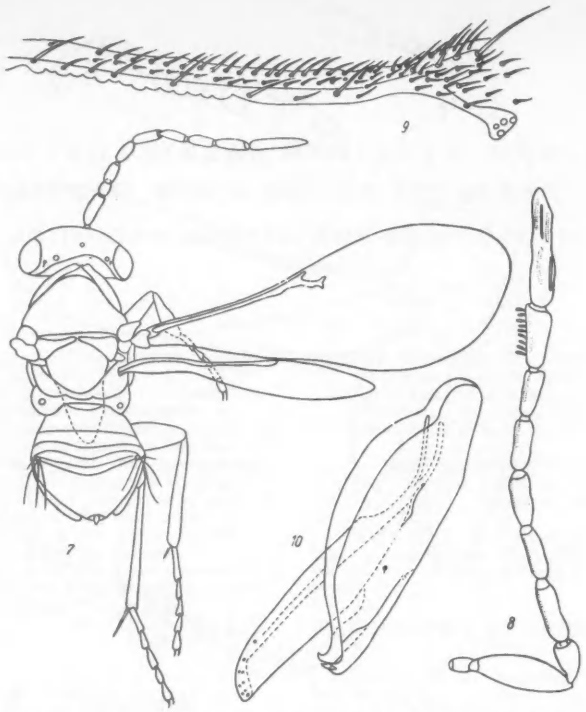
The body color is dirty brown, the vertex and frons brownish-yellow, the face and genae rusty yellow, the antennae brown or brown and yellow, as are the legs; the tips of the claws are darker. The length is 0.8 - 1.0 mm.

Material used: Kakhaberi, Batumi region, 23 May - 2 July 1958, 9 ♂♂ (Liao Ting-Hsi, V. Tryapitsyn).

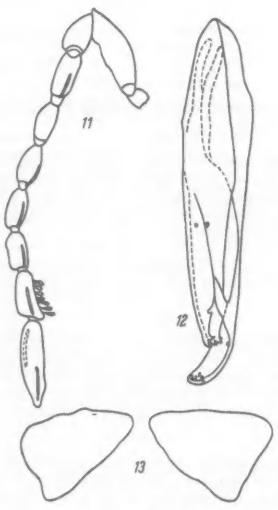
The male resembles the male of Rh. flavidus (Merc.), except that in the latter the scape is somewhat shorter than the first two funicular segments combined and the body is yellow and slightly brownish with blackish coloration at the edges of the mesonotum, scutellum and axillae, while the antennae are whitish.

The genus Rhopus belongs to the tribe Ectromini Ashmead; according to Erdoes and Novicky (1955), however, it belongs to the subtribe Rhopina of the tribe Leptomastidini. The genera nearest to it are Platyrhopus Erd. and Doliphoceras Merc. Examination of specimens of Doliphoceras integralis Merc. from the Batumi area has revealed substantial differences between the genera.

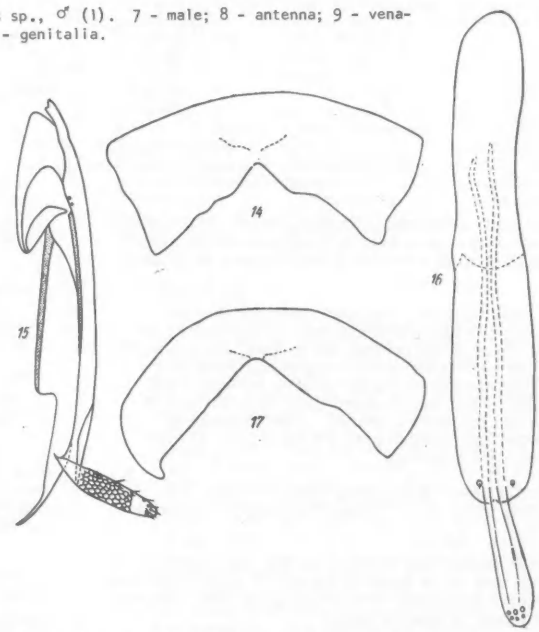
Doliphocera Merc.	Rhopus Först.
Unsegmented pronotum (Fig. 14).	Pronotum divided into two triangular sclerites (Fig. 13).
Maxillary palpi have 3 segments, labial palpi 2 segments.	Maxillary palpi have 2 segments, labial palpi one segments.
Ovipositor (Fig. 15) protrudes slightly; third valvulae developed.	Ovipositor (Fig. 6) does not protrude, third valvulae practically undeveloped.



Figs. 7 - 10. Rhopus sp., ♂ (1). 7 - male; 8 - antenna; 9 - venation of forewing; 10 - genitalia.



Figs. 11 - 13. Rhopus sp. ♂ (2). 11 - antenna; 12 - genitalia; 13 - pronotum.



Figs. 14 - 17. Doliphoceras integralis Merc. 14 - female pronotum; 15 - ovipositor; 16 - male genitalia; 17 - male pronotum.

No digital sclerites (Fig. 16).

Developed digital sclerites (Figs. 10, 12).

The structural differences in the pronotum and palpi of the males are the same as in the females. It is noteworthy that absence of digital sclerites has so far been noted only in the genus Leucospis F. (Nikol'skaya, 1960).

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NEW FIGITIDAE (HYMENOPTERA, CYNIPOIDEA) IN THE FAUNA OF THE USSR

V. I. BELIZIN

The species making up the Figitidae fauna of the USSR have been covered at some length in earlier works by the present author (Belizin, 1951, 1952, 1954). Since these papers appeared, however, many Figitidae species have again been accumulated in the USSR Academy of Sciences Institute of Zoology and have been worked on by the author. The publication of this work is of great scientific interest, since several species previously unknown to science have been found among the fauna of the USSR and described, a great deal more is becoming known about their distribution in the USSR and the areas in which they are to be found are becoming more clearly defined.

The present taxonomy of the superfamily Cynipoidea assigns fairly distinct and generally accepted boundaries to the family Figitidae. It includes the subfamilies Anacharitinae, Aspicerinae and Figitinae, which form a morphologically and ecologically fairly homogeneous group. All species of the family are parasitic on files, including flies harmful to agriculture and forestry, and also on flies which annoy man. Some species are secondary parasites on aphids (Melanips Walk.).

All the examples mentioned in this paper, including the type specimens of the new species, are preserved in the Leningrad Institute of Zoology.

Superfam. ANACHARITINAE

1. Aegilips paucus V. Belizin, sp. nov.

♂. Black; legs yellowish-red except that hind legs are black at the bases of the coxae. Head smooth and shining; face thickly punctate, with numerous light hairs. A broad mat band with delicate reticular sculpturing extends from the base of the maxillae to the lower edge of the compound eye along the edge of the genae. The face and clypeus are convex, the mandibles yellowish-red. Dorsal edges of genae edged with a row of sparse gray hairs.

Propleura hairy, their ventral edge bordered with a thick row of gray hairs pointing backwards. Propleural surface smooth, with some furrows in the lower anterior angle. Mesopleura smooth and shining, their lower third longitudinally wrinkled. Metapleura mat, coriaceous. Mesonotum smooth, bare and shining. Only superficial, very indistinct traces of parapsidal grooves. Scutellum conical, gradually sharpening towards apex, with no trace of spines; entire surface of disc densely and reticularly wrinkled; pits, large, smooth, shining and set obliquely, make up slightly less than one third the length of the scutellum. Median segment covered with thick, gray hairs, mat, reticularly wrinkled.

Wings transparent and covered with short, thick hairs; veins broad, light yellow. Radial cell closed, narrow and two and a quarter times longer than it is wide. No areolet; cubitus and media not distinct. Legs, especially the median ones, and hind coxae, covered with long, light hairs.

Abdomen smooth and shining; petiole furrowed and shorter than its width; base of second segment brown.

Body length 2.2 mm.

Holotype: 1 ♂ collected in Kazakhstan, S. Kazakhstan province, Karzhantau, upper reaches of the Su-Singan, on 6 July 1939 (Obukhova).

Differs from Aeg. dalmani H. Reinh. by its completely smooth mesonotum, without parapsidal grooves or rugae and smooth, impunctate propleura.

2. Aegilips gemellus V. Belizin, sp. nov.

♂. Black; antennae, mandibles and legs brown; the greater part of the first antennal segment and the coxae of all legs black; femor brown.

Head smooth and shining, covered with sparse, light hairs. Third antennal segment longer than fourth or fifth, which are of equal length; terminal segments successively shorter.

Propleura shining, rugulose below and punctate above; mesopleura shining and smooth, delicately punctate along anterior edge; metapleura bare, with short rugae.

Mesonotum shining, entirely covered with sparse, very distinct punctures. Parapsidal grooves distinct but weak, wanting in front. Anterior parallel furrows very delicate, not well marked and widely separated; a depression, not very pronounced, between the parapsidal grooves near the scutellum; lateral furrows very delicate, curved, but distinct. Scutellum conical; anterior half of disc smooth and shining, sides and top reticularly furrowed, sharply margined; pits smooth, not very obvious, separated by a sharp ridge. Median segment reticularly furrowed, covered with sparse smoky hairs; median area mat with three slightly protuberant carinae, the lateral ones curved outwards, the central one straight.

wings transparent, covered with thick, short hairs; veins wide and light yellow; cubitus and media quite indistinct; radial cell narrow, two and a quarter times as long as its width; second branch of radius one and a half times longer than first; no areolet.

Legs covered with short, light hairs.

Abdomen shining, smooth; petiole very short and furrowed.

Body length 1.8 mm.

Holotype: 1 ♂, Miass, Ilmenskiy Reservation, Chelyabinsk province, 15 July 1958 (V. Tobias).

Similar to Aeg. striolata Cameron but differing in that the propleura, mesopleura and mesonotum are shining, the parapsidal grooves less obvious, the petiole very short and the color of the antennae and legs darker.

3. Aegilips dalmani H. Reinhard.

New for the USSR fauna. Found in Transcaucasia.

Armenia: Yerevan, 11 May 1957, 1 ♂ (V. Tryapitsyn); Goris, 19 September 1956, 1 ♂ (V. Tryapitsyn). Georgia. Bakuriani, 16 July 1958, 1 ♂ (V. Tryapitsyn).

4. Anacharis ensifera F. Walker.

New for the USSR fauna.

Ukraine, L'vov, 28 July 1958, spruce cones, 1 ♂ (I. Zagaychkevich).

5. Anacharis typica F. Walker.

This species has now been found in the following localities, with the result that its known distribution in the USSR has been greatly extended:

Ulyanovsk, 24 July 1958, 3 ♂♂ (V. Tobias). Chelyabinsk prov., Miass, Ilenskiy Reservation, 12-14 July 1958, 4 ♂♂ (V. Tobias). Georgia, Oladauri, Adzharian ASSR, 17 August 1958, 1 ♂ (V. Tryapitsyn).

6. Anacharis rufiventris Hartig.

Chelyabinsk province, Miass. Ilmenskiy Reservation, 14 July 1958, 1 ♀ (V. Tobias). Armenia, Shurnukh, 11 September 1956, 1 ♀ (V. Tryapitsyn).

7. Xyalaspis lituricis V. Belizin, sp. nov.

♂. Black; antennae unicolorous, yellowish-red; legs yellow, hind coxae black.

Head smooth, shining, covered with sparse, large punctures and sparse, long hairs; posterior edges of genae with a row of long gray hairs. Clypeus large, convex; mandibles light yellow. A mat band with delicate reticular sculpturing extends from base of maxillae along boundary between face and genae to lower edge of compound eye. Face very convex, frons smooth. Antennae have 14 segments and are filiform; all flagellar segments almost cylindrical, longitudinally furrowed; second segment slender at base, widening pear-shaped apically, slightly longer than wide; third segment slightly shorter than fourth; the rest equal in length to the third; terminal segment one quarter longer than penultimate segment.

Propleura shining, anterior half reticularly furrowed, posterior half covered with rows of large punctures. Anterior half of mesopleura longitudinally aciculate, posterior half smooth and shining. Metapleura mat and rugulose. Mesonotum smooth, shining and covered with sparse receding hairs. Parapsidal grooves distinct throughout their length; mesonotum covered with delicate transverse wrinkles on both sides of the parapsidal grooves; conical scutellum ending with a distinct straight spine up to one third the length of the scutellum; scutellar disc and spine reticularly wrinkled; pits at base of scutellum large and smooth. Median segment reticularly wrinkled, covered with long, gray hairs, and with three more or less distinct carinae.

Wings transparent and closely covered with hairs; veins broad and yellow. Radial cell closed along anterior edge and two and a half times as long as its width. No areolet; cubitus and media indistinct.

Abdomen smooth and shining; petiole wrinkled, slightly longer than its width; seventh tergite bears a tuft of slender white hairs.

Body length 2 mm.

Holotype and paratypes: Kazakhstan, L. Zharkol', Akmolinsk prov., 8 August 1957; 10 June-1 July 1958 (V. Tobias), 4 ♂♂; 22 June 1958, 1 ♂ (Sokolova).

Similar to X. subulifera C. Thoms. and X. petiolata Kieff. Distinguished from the former by the straight spine, smooth scutellar pits and punctate propleura; from the latter by the large smooth pits and short petiole. Further distinguished from both species by having pronounced wrinkling only around parapsidal grooves instead of over entire mesonotal surface.

8. Xyalaspis hyalinus V. Belizin.

This species has now been found in the following new localities:

Armenia, Yerevan, 25 September 1956 and 22 September 1957, 2 ♂♂ (V. Tryapitsyn). Kazakhstan, L. Zharkol', Akmolinsk prov., 8 July-8 August 1957, 2 ♂♂ (V. Tobias).

These specimens are similar to the above but differ in having the anterior edges and lower half of the propleura wrinkled, the first antennal segment slightly shorter than the third, no parapsidal grooves in front and a reticularly wrinkled median segment without clearly defined carinae.

PETRICYNIPS V. Belizin, gen. nov.

Head considerably wider than thorax. ♀ antennae have 13 segments, are short and gradually thicken towards tip. Thorax massive, of uniform sculpture, delicately coriaceous, slightly shiny, with only the mesopleura very delicately aciculate. No parapsidal grooves except for a slight hint of them. Scutellum divided from mesonotum by a distinct suture but instead of pits at the base there is a narrow, arcuate, very distinct but superficial furrow. Scutellar disc terete, without border, and of the same uniform sculpturing as the whole mesonotum. Abdomen smooth, slightly compressed laterally, shorter than thorax. Petiole slightly longer than its width and considerably shorter than the hind coxa.

Defective specimen (wingless).

This genus differs from all other genera of the subfamily in having a dentate clypeus, a narrow semicircular furrow at the base of the scutellum instead of pits, a terete scutellum without border, no parapsidal grooves and a short petiole.

Generic type: Petricynips micuisis V. Belizin, sp. nov., Tadzhikistan.

9. Petricynips micuisis V. Belizin, sp. nov.

♀. Black except for yellowish-red antennae, clypeus, mandibles and legs. Head considerably wider than thorax, V-shaped when viewed from in front, delicately coriaceous, slightly shiny, mat on vertex. Clypeus stands out well and is red, with a denticle in the angle of the lower edge on each side. The genae are not separated from the face by a furrow; their length is 0.6 that of the compound eye. The antennae have thirteen segments and are short, but slightly longer than head and thorax combined; the flagellar segments successively gradually lengthen towards the tip of antenna and become thicker and darker; only the first and second segments are of equal length; the thirteenth segment is twice as long as the twelfth.

The thorax is sturdy, and except for the mesopleura is uniformly sculptured throughout with a slightly shiny, delicately coriaceous surface; the mesopleura, though also slightly shiny, are very delicately aciculate. There are no parapsidal grooves, apart from slight traces. Anterior parallel and lateral furrows can also just be discerned. The scutellum is terete and rises slightly above the median segment on a base which has a narrow semicircular superficial furrow instead of pits. The median segment is bare and of the same sculpturing as the other thoracic sclerites.

The legs are yellowish-red, the hind coxae a darker, cinnamon-brown color.

Abdomen smooth, shining; second segment making up 0.4 of the abdominal length; petiole shorter than hind coxa.

Body length 1.0 mm.

Holotype: 1 ♀, Pamirs, Pyotr Pervyy ridge, Zakh-Bursi pass, 5 July 1913 (Gol'bek).

STYLOBRACHYS V. Belizin, 1951

When this genus was described it was wrongly referred to the subfamily Anacharitinae; in fact it should be listed under the subfamily Mesocynipinae, fam. Liopteridae.

It is very similar to Paramblynotus Cameron, from which it is distinguished by the absence of scutellar pits; by a scutellum equal in length to the 3rd and 4th antenna segments and a shorter terminal antennal segment in both the males and the females; by the absence of denticles on the posterior edge of the pronotum, a shorter median segment with three longitudinal carinae on it, unthickened hind coxae and femora and parapsidal grooves which are distinct over the entire length.

It differs from Mayrella Hedicke in that the female has the antennae thirteen-segmented and three instead of two carinae on the median segment.

To the original description of gen. Stylobrachys should be added the following characteristics: petiole short but distinct and furrowed; fifth abdominal tergite the longest; abdomen as long as head and thorax combined; hind tarsi without spurs on first and second segments.

Superfam. ASPICERINAE

10. Aspicera tobiasi V. Belizin, sp. nov.

♀. Head and abdomen black; thorax yellowish-red except for chestnut-brown median segment and metapleura.

Face mat, coarsely coriaceous, covered with short, light closely-set hairs. Clypeus convex, of the same sculpturing; its lower edge and that of the genae at the base of the mandibles covered with long brown hairs; genae have two oblique carinae; a bulging circular protuberance below, joined by a convex line to the clypeus. A raised carina on each side, from the base of the antennae parallel to the inner edge of the compound eye and near the eye, reaches the level of the superior ocelli. Frons and occiput coarsely reticularly wrinkled.

Antennae 13-segmented, filiform; the first two segments black, the flagellar segments lighter, yellowish-red; first segment pyriform, second transverse and shorter than its width, the rest cylindrical; third slightly shorter than fourth; fourth to eighth equal, ninth to twelfth slightly shorter; terminal segment a little more than twice as long as the penultimate.

Mesonotum shining, smooth, with a few indistinct transverse wrinkles. Anterior edge and sides of mesonotum covered with short, light hairs. Mesonotal carinae weak and indistinct; lateral carinae do not join the median and do not reach the level at which it forks. Parapsidal grooves broad and pronounced. Lateral furrows at first (at base of scutellum) wide, then continuing almost as far as the pronotum in the form of indistinct carinae. Anterior third of mesonotum covered with large but shallow punctures. Scutellum one and a half times longer than its width and of the same color as the mesonotum except for its lateral border and spine, which are black. Pits at scutellar base smooth, occupying two fifths of the length of scutellum; disc smooth, with longitudinal carinae. Under the lateral edge of the spine, a dense row of short, thick, light hairs. Spine one third as long as scutellum.

Propleura slightly shiny above, closely covered with short hairs, with longitudinal wrinkles set close together; lower part smoother and more shiny, with three more pronounced wrinkles. Mesopleura smooth and shiny, their posterior lower angle near coxae of median legs closely covered with short, silvery hairs. Metapleura mat, coarsely roughened and also closely covered with short, silvery hairs. Median segment has a bare, mat, circular area in the middle; its sides are closely covered with long silvery hairs.

Legs unicolorous, yellowish-red.

Wings transparent, bare, with broad yellowish-brown veins. Radial cell twice as long as wide.

Abdomen pitch-black and shiny; petiole pitch-brown, narrow, costate. Second tergite bare and smooth, without a depression. Base of third tergite smooth, then closely covered with delicate punctures all the way to the end.

Body length 4-4.2 mm.

Holotype and paratypes: Kazakhstan, Dzhezkazgan, Karagandinsk prov., 25 June 1958, 2 ♀♀, (V. Tobias); V. Tobias also collected one more ♀ at Zhan Arka (same prov.) on 21 June 1958.

The species is very similar to A. brevispina Kieff, from which it is distinguished by the smooth, carina-free mesonotum punctate in its anterior third.

11. Aspicera brevispina Kieffer.

The area in which this species is known has been considerably extended to the north and east; specimens have been found in the following places:

Primorskiy territory, Ussuriysk, 21 July 1935, 1 ♀ (N. Telenga). Kazakhstan: Kent Mountains, Karagandinsk prov., 23 July 1957, 1 ♂ (V. Tobias); Zhana Arka, same prov., 9-18 June 1958, 24 ♂♂ and 1 ♀ (V. Tobias); all ♂♂ completely black. Tadzhikistan, Kurgan-Tyube, 24 June 1939, 1 ♀ (V. Kryzhanovskiy).

12. Aspicera tenuispina Kieffer.

Chelyabinsk prov., Miass. Ilmenskiy Reservation, 14-20 July 1958, 3 ♀♀ (V. Tobias).

13. Aspicera sibirica Kieffer.

Kazakhstan. Zhana Arka, Karagandinsk prov., 11 June 1958, 1 ♀ (V. Tobias).

14. Aspicera scutellata (Villers).

Kursk prov., Sudzha, 28 June 1959, 1 ♀ (V. Belizin). Kazakhstan: Kokshetau Mountains, Akmolinsk prov., 16 June 1957, 1 ♀ (V. Rudolf); also 25 June 1957, 1 ♀ (R. Sokolova); also 11 August 1957 and 3 July 1958, 1 ♂, 1 ♀ (V. Tobias); Kent Mountains, Karagandinsk prov., 23 July 1957, 1 ♀ (V. Tobias); Zhana Arka, 9-18 June 1958, 19 ♂♂, 2 ♀♀ (V. Tobias).

Males entirely black.

15. Callaspidia areolata Kieffer.

New species in USSR fauna.

Kazakhstan: Kent Mountains, Karagandinsk prov., 24 July 1957, 1 ♂ (V. Tobias).

Areolet small but well marked. Coxae in this specimen red; femora darker (cinnamon-brown-red).

16. Callaspidia aberrans Kieffer.

The females of this species have not previously been described. As they differ substantially from the males, the following description is given, based on specimens from Tadzhikistan.

♀. Head, thorax, antennae and legs red. A large, mat, black area, shield-shaped, with two denticles pointing downwards, on face under antennae, demarcated laterally and below by carinae. Mesonotum sometimes partly black.

Head somewhat wider than thorax, with an almost straight posterior edge. Face and genae behind compound eyes coarsely transversely wrinkled. Compound eyes strongly bulging. Antennae filiform; third segment appreciably longer than fourth, terminal segment equal to third and two and a half times as long as penultimate.

Pronotum shield-shaped, descending perpendicularly to head, densely punctate above and covered with sparse, short, adjacent hairs, smooth and bare underneath. Propleura large, coriaceous, partly or entirely transversely wrinkled. Mesonotum coriaceous, almost mat. Parapsidal furrows wide, distinct throughout, the bottom of the furrows being red. One carina, forked in the rear third of the mesonotum and forming a triangular area, which is between the parapsidal furrows in the middle of the mesonotum and is two and a half times longer than its width. Scutellum always red, elongated, slightly compressed at the apex. Pits elongated, making up almost half the length of scutellum, smooth-bottomed. Scutellar disc with three carinae, two of which demarcate the scutellum laterally while the central one separates the pits; surface of disc has pits between the central and lateral carinae on each side with four coarse, transversal wrinkles. Mesopleura mat above, closely and delicately aciculate; smooth and shiny below. Metapleura mat, closely covered with long, white hairs.

Legs long; hind femora in ♀ extend to the end of the third abdominal segment, in the ♂ pass beyond the apex of the abdomen. All coxae and femora

densely punctate; hind tibiae with longitudinal carinae. Wings transparent, with sparse cilia; veins pale, yellow or yellowish-gray

Abdomen smooth, shiny, pitch black. Petiole red, longitudinally furrowed. Second tergite with a basal depression, the surface of which is closely covered with short, white hairs. This depression is absent in the male.

Body length 3.8 - 4.0 mm.

Tadzhikistan: Stalinabad, 12-14 October 1943, 3 ♀♀, 1 ♂ (V. Popov); Kondara, 10-14 September 1945, 2 ♂♂, 1 ♀ (V. Gussakovskiy); Mikoyanabad, 26 June 1934, 1 ♀ (V. Gussakovskiy).

In addition, the known distribution area of this species within the USSR has been considerably extended by findings at the following places:

Turkmenia: Farab, 5 May 1912, 1 ♀ (Gol'bek). Kazakhstan: L. Zharkol', Akmolinsk prov., 11 June 1957, 1 ♀ (V. Tobias). Armenia: Shurnukh, 1 September 1956, 1 ♀ (V. Tryapitsyn).

17. Callaspidia defonscolombei Dahlbom.

Turkmenia: Ashkhabad, 21 May 1934, 1 ♂ (V. Popov); Farab, Uch-Adzhi, 5-6 May 1929, 3 ♂♂, 2 ♀♀ (A. Shestakov). Tadzhikistan: Stalinabad, 12 May 1943, 3 ♀♀ (V. Popov). Kazakhstan (Turkestan): S. Kazakhstan prov., 1 ♂ (Trizna), Chelyabinsk prov., Miass. Ilmenskiy Reservation, 12-18 July 1958, 2 ♀♀ (V. Tobias).

18. Callaspidia dufouri Giraud.

Kostromskaya prov., Baydarka, 26 July 1933, 1 ♀ (V. Gussakovskiy), Chelyabinsk prov., Miass, Ilmenskiy Reservation, 15 July 1958, 1 ♀ (V. Tobias).

Superfam. FIGITINAE

19. Lonchidia riphaeica V. Belizin, sp. nov.

♀. Black except for mandibles, legs, second abdominal segment and part of the antennae, which are red to cinnamon-brown.

Head shining, smooth, elongated; face convex, covered with sparse, slender, light hairs; clypeus clearly demarcated; genae one third longer than compound eye. Antennae 13-segmented and almost as long as the body; first segment dark brown, second yellowish red, elongate oval; from third segment onwards the antenna reddish brown, gradually darkening towards the tip to dark cinnamon-brown; segments III-VIII slender, widening slightly apically; the third one third longer than the fourth and also longer than the others up to and including the eighth; the last five forming a distinct club and becoming gradually thicker and on towards the tip; the terminal segment the longest and thickest, its length being equal to the combined length of the two preceding segments.

The anterior edge of the propleura and pronotum closely covered with light hairs; the rest of the propleura bare, smooth and shining. The mesopleura smooth, shining and with three deep, straight striae in the lower part, which just fall short of the posterior edge of the mesopleura. The mesothorax densely covered with silvery hairs. The metapleura and sides of the median segment mat and densely covered with short, silvery hairs. Mesonotum smooth, shining, convex, with no trace of parapsidal grooves and covered with sparse, slender, light hairs. There is a wide, smooth, rectangular depression (pit) at the base of the scutellum; the scutellar disc is covered with light hairs and slightly shiny; it inclines down towards the median segment at almost a right angle to the mesonotum; there are three slender furrows on the disc dorsally. The median segment has two sharp, curved, light brown carinae, demarcating a median lyrate area closely covered with short, silvery hairs.

Wings opaque, of a uniform smoky color and densely covered with hairs. Radial cell short, open at the anterior wing edge. Areolet represented by one vein; cubitus and media transparent and indistinct.

Legs long, covered with short, light hairs; hind coxae and thickened parts of femora of all legs darker; posterior edge of hind coxae with a brush of closely set silvery hairs.

Petiole black, smooth. Second abdominal segment light, with its sides closely covered at the base with long silvery hairs. The third segment constituting the greater part of the abdomen, its apex being almost that of the abdomen. The hypopygium of a smoky color and not protruding beyond the apex of the abdomen. The abdomen slightly compressed laterally and broad dorsally.

Body length 1.5 mm.

Holotype and paratype: 2 ♀♀, 12-15 July 1958, Ilmenskiy Reservation, Chelyabinsk prov. (V. Tobias).

Differs from all other species of the genus in having opaque smoky wings, thickly covered with hair.

20. Anolytus bicoloratus V. Belizin, sp. nov.

♂. Black; abdomen reddish brown.

Head and thorax uniformly coriaceous, mat, closely covered with hairs; only the mesopleura shining, bare and smooth though somewhat aciculate below and in front; facial and clypeal hairs dense and long, concealing the sculpture.

Antennae have fourteen segments, are filiform and equal in length to the body; first segment dark brown, all the rest a lighter, reddish brown; flagellar segments cylindrical, the first shorter than the second and notched at the base; from the second to the sixth all the flagellar segments of the same length; the following segments gradually shorter; the terminal segment not thicker but slightly longer than the penultimate.

The pronotum is broad and slopes gently towards the head. No parapsidal grooves, only two very short, narrow furrows posteriorly, near the scutellum. Lateral furrows very thin and indistinct. No trace of pits at base of scutellum; disc with coriaceous sculpturing, coarser than that of mesonotum. Median segment covered with close, silvery hairs, has two very slender carinae marking off a central area which is also closely covered with silvery hairs.

Wings closely covered with hair. Radial cell elongated, two and a half times longer than its width, more than half closed along the anterior edge. No areolet. Cubitus and media indistinct.

Abdomen smooth and shining; second tergite with a tuft of hair at the base; third segment very large, taking up the greater part of the abdomen; petiole short and somewhat longer than its width.

Body length 1.3 mm.

Holotype: 1 ♂, Miass, Chelyabinsk prov., Ilmenskiy Reservation, 15 July 1958 (V. Tobias).

Differs from the only known species of this genus, A. rufipes Foerst., by the almost total absence of parapsidal grooves by having the radial cell largely closed on anterior wing edge, and by the smooth, impunctate coxae.

21. Sarothrus tibialis Zetterstedt.

Kazakhstan, Kokshetau Mountains, Akmolinsk prov., 28 May 1957, 1 ♂ (V. Tobias).

SARATHRIOIDES V. Belizin, gen. nov.

Face covered with striae which spread fanwise. Antennae filiform and 14-segmented in both ♂ and ♀; third antennal segment of male strongly curved, as long as fourth. Thorax coriaceous and shining; parapsidal grooves distinct over entire length of mesonotum. Scutellum granularly wrinkled and with

two smooth pits at the base. Radial cell closed. Areolet weakly indicated. Abdomen smooth and longer than head and thorax combined. Second tergite hairy at the base.

Generic type: Sarothrioides frequentus V. Belizin, sp. nov.

Very similar to Sarothrus Hartig, from which it differs in that the female has 14-segmented antennae, the third antennal segment in the male is curved, the face is striate and not punctate, and the abdomen is smooth and impunctate.

22. Sarathrioides frequens V. Belizin, sp. nov.

♂♀. Head and thorax black, abdomen and antennae reddish-brown, legs yellowish-red.

Head shining, delicately shagreened on vertex; face covered with short, light hairs, with fine striae spreading fanwise from the exterior angles of the smooth clypeus; mandibles yellowish-red with black denticles. Female antennae 14-segmented, filiform; flagellar segments almost cylindrical except that the first narrows at the base; first antennal segment almost the same length as second, third, fourth and fifth; sixth to last segments progressively shorter, except that the last is slightly longer than the penultimate. ♂ antennae also 14-segmented, the third being strongly curved, narrower than the succeeding segments and of the same length.

Pronotum shining, delicately shagreened and, with the propleura, closely covered with short, thickly placed hairs. Mesopleura shining, bare and thickly streaked with fine, sharp striae. Metapleura bare and shagreened. Mesonotum shining and coriaceous, very delicately wrinkled transversely posteriorly near the parapsidal grooves, and with sparse but large punctures. Parapsidal grooves distinct over entire length of mesonotum; two deep parallel furrows between them anteriorly and a wide, deep median furrow extending from middle of mesonotum to the scutellum; lateral furrows between the parapsidal grooves and the outer edges of the mesonotum distinct. Scutellum oblong-circular; disc with rougher sculpturing than mesonotum, granularly wrinkled and with two smooth shining pits at the base.

Wings transparent, with dense short hairs on the outer edges and closely ciliate on the surface. Veins broad, light brown. Cubitus and media distinct. Radial cell closed, narrow and long, almost three times as long as it is wide. Areolet not distinct. Legs yellowish red.

Abdomen shining and smooth, darker at the apex, longer than head and thorax combined; anterior edge of second segment laterally covered densely with hairs.

Body length: ♀ 1.7 mm, ♂ 1.2 mm.

Primorskiy territory (kray), Ussuriysk Experimental Station, 30 May 1935, 1 ♂ 1 ♀ (holotype and allotype) (A. Mishchenko).

MELANIPS Walker

This genus, long known under the name of Amblynotus Hartig, was combined with Sarothrus Hartig by Hellen (1936), but is now generally recognized as an independent genus under its original name. Its species are widely distributed and numerous in the USSR; many seem to be endemic.

23. Melanips arnoldii V. Belizin, sp. nov.

♂. Black. Antennae, except first segment, and legs, except coxae, a light yellowish-red.

Head mat, very delicately coriaceous; the face has an elongated smooth elevation under the antennae, the sides of this elevation being wrinkled; the clypeus smooth and sharply delimited, at an angle to the face above the light brown mandibles; a row of short dark gray hairs on the lower edge of the clypeus, the upper exterior angles of which are depressed to form a pit-like cavity at each side. Antennae filiform, 14-segmented; third segment almost without curvature and more slender but one and a half times longer than the fourth; the remaining flagellar segments cylindrical, becoming successively shorter towards the tip; terminal segment only a quarter the length of the preceding one.

Pronotum shining, smooth, with a heart-shaped notch above. Propleura bare, mat and delicately coriaceous. Mesopleura shining, bare, densely aciculate. Metapleura shining, bare and smooth. Sides of median segment coarsely wrinkled, closely covered with short, dark hairs; central area smooth, shining, with almost parallel lateral carinae and a less elevated, narrow carina in the middle of the lower half.

Mesonotum mat and coriaceous, covered with short, recumbent gray hairs. Parapsidal grooves distinct throughout their entire length, very wide posteriorly. Two distinct parallel furrows set wide apart in the anterior third of the mesonotum, between parapsidal grooves; a deep median furrow running from middle of mesonotum to scutellum, between parapsidal grooves. Lateral furrows between parapsidal grooves and outer edges of mesonotum distinct. Two smooth, narrow, slightly curved transverse pits at base of scutellum. Disc mat, coriaceous, its posterior half narrowing slightly towards the apex and sloping downwards, coarsely covered with reticular wrinkling.

Wings transparent and with dense short pile and cilia; veins brown, only the cubitus and media being pale and very indistinct. Radial cell closed along anterior wing edge and two and a half times longer than its width. Areolet represented by only one vein.

Coxae black, smooth and shining; other parts of legs a light yellowish red.

Abdomen with a long, mat, furrowed petiole and smooth and shining. Second segment red at base, with a thick tuft of long, light hairs on each side; sixth and seventh segments closely covered with delicate punctures.

Body length 2.3 mm.

Kazakhstan, Kruglyy, north of Kalmykovo, 10 May 1951, 1 ♂ (holotype)(L. Arnoldi).

Resembles M. Sibiricus V. Bel., from which it differs in having light-colored antennae; mesopleura entirely aciculate; a deep median furrow in the mesonotum between parapsidal grooves; scutellum coarsely reticularly wrinkled at the apex; no areolet; cubitus and media indistinct and lighter than the legs.

24. Melanips confinis V. Belizin, sp. nov.

♀. Black, mat. Head slightly shiny; frons and genae coriaceous; face covered with fine striae spreading fanwise from the bases of the mandibles to the antennae. Mandibles chestnut to cinnamon-brown with black teeth. Antennae 12-segmented, dark-brown, filiform; second segment large and spherical; third segment the most slender and a quarter shorter than the fourth; the eighth to the eleventh inclusive all of a length with the third, the twelfth two and a quarter times as long as any of these.

Propleura and mesonotum uniformly sculptured, mat, covered with sparse, short hairs and coriaceous, with very delicate, close, aciculation. Parapsidal grooves distinct from the middle of the mesonotum to the scutellum. Two short, barely noticeable furrows in the anterior part of the mesonotum. Scutellum somewhat more coarsely sculptured than the mesonotum; disc coriaceous, without furrows; pits quite distinct, smooth, set obliquely, narrow. Mesopleura mat, streaked throughout with close fine aciculation. Metapleura mat, very narrow and with deep furrows. Median segment mat, outer superior angles elevated to form blunt spines.

Wings covered closely with short hairs, slightly smoky; veins wide, dark brown. Radial cell closed along anterior edge; third branch of subcosta and first branch of radius strongly curved; length of radial cell three times its width. Areolet distinct. Coxae of all legs black, femora reddish brown,

tibiae and tarsi lighter and red.

Abdomen massive; petiole and base of second segment red, with tufts of hair on the sides of the latter; third and following segments closely covered with delicate punctures; hypopygium smoky.

Body length 1.8 mm.

Holotype: 1 ♀, Kokshetau Mountains, Akmolinsk prov., 25 May 1957 (V. Rudol'f). Paratype: 1 ♀, same locality, 28 May 1957 (V. Tobias).

The species resembles M. granulatus Htg., from which it differs in having a coriaceous but impunctate, delicately aciculate mesonotum, a coriaceous but impunctate scutellum and an aciculate face.

25. Melanips antennalis V. Belizin, sp. nov.

♀. Head and abdomen black; thorax dark chestnut to cinnamon-brown.

Head smooth, shining and bare; only the face covered with short, light hairs. Mandibles and clypeus a bright yellowish-red; clypeus wide and convex. Antennae filiform, 13-segmented, light, all yellow except the first segments, which are brown; flagellar segments cylindrical, the first one being conspicuous because of its length, which is almost equal to that of the next two combined; terminal segment one and a half times longer than the penultimate.

Propleura slightly shiny and densely covered with close, short, light hairs. Mesopleura bare, smooth, shining and divided into two halves by a suture. Metapleura mat and covered with dense, light hairs. Pronotum convex, slightly shiny, delicately punctate, thickly covered with short, light hairs. Very distinct parapsidal grooves in posterior half of mesonotum, none in front. Very noticeable anterior furrows reaching almost to the middle of the mesonotum.

Scutellum smooth, shining, convex and covered with close, light hairs. Pits very small and indistinct.

Legs long, almost entirely yellowish red; hind tibiae slightly curved.

Wings dark, smoky; covered with close, short hairs. Veins dark, almost black. Radial cell long (almost three and a half times as long as its width) and narrow. Areolet consists of two veins set wide apart. Cubitus distinct almost to a wing edge.

Abdomen short, smooth, shining. A broad dense band of hairs at base of second segment; third segment also with a sparse row of single short hairs; second and third tergites form a kind of casing that almost covers the other abdominal segments.

Body length 1.6 mm.

Holotype: 1 ♀ (holotype), Ilmenskiy Reservation, Chelyabinsk prov., near Miass, 15 July 1958 (V. Tobias).

The species most resembles M. granulatus Hartig, from which it differs in having no punctation on the head, scutellum and abdomen, lighter antennae and very small, indistinct pits.

M. confinis, sp. n., differs from the species described in having a very long first flagellar segment, a punctate instead of an aciculate mesonotum, smooth instead of aciculate mesopleura, a smooth and shining instead of coriaceous scutellar disc and a smooth impunctate abdomen.

26. Melanips gussakovskii V. Belizin, sp. nov.

♂♀. Black; abdomen dark brown; pronotum, mesonotum and scutellum sometimes reddish brown.

Head coriaceous, slightly shiny, without punctures or striae; mandibles reddish brown; face densely covered with hairs; clypeal hairs light and gathered into a tuft pointing downwards. Antennae yellowish red, the first two and the last five or six segments a darker reddish brown. ♀ antennae 12-segmented, filiform, with the second segment elongated and slightly thickened at the tip, the third more slender than any of the rest and shorter by a quarter than the fourth and fifth, which are of equal length, and sixth and following segments becoming successively shorter and thicker towards the tip and the twelfth almost twice as long as the eleventh. The ♂ antennae have thirteen segments, of which the third is the most slender and is slightly notched at the base, slightly longer than the second and slightly shorter than the fourth, while the fifth to eighth inclusive are the longest and the rest become shorter towards the tip; the thirteenth segment is more than twice as long as the twelfth.

Propleura slightly shiny and coriaceous; mesopleura streaked throughout with close, fine striae; metapleura mat, coriaceous and covered with close, light hairs. Mesonotum coriaceous, slightly shiny. Parapsidal grooves distinct over their whole extent but deeper in the posterior half of the mesonotum; anterior parallel furrows short and indistinct; a deep median furrow between the parapsidal furrows in the posterior third of the mesonotum. Scutellum slightly coarser than mesonotum, with coriaceous sculpture of reticular outline; pits at base of scutellum distinct, smooth, shining and oblique. Median segment hairy, wrinkled, with a smooth central area.

Wings transparent, slightly smoky, closely covered with hairs. Radial cell closed, two and a quarter times longer than its width; first radial branch strongly curved into radial cell. Areolet distinct; cubitus and media distinct almost to wing edge.

Legs yellowish red, coxae reddish-brown.

Abdomen shining, smooth; base of second segment covered with hairs; hypogium smoky; fourth and following segments closely covered with very delicate punctures.

Body length 1.2 - 1.5 mm.

Types and paratypes: 1 ♂ and 3 ♀♀ in all, Tadzhikistan Stalinabad, 19-29 May 1934 (V. Gussakovskiy).

The species is nearest to M. striolatus Hart. but is readily distinguishable by the coriaceous sculpturing of the head, which has no striae or punctures, the densely aciculate mesopleura, and the shorter radial cell.

27. Melanips opacus Hartig.

Kazakhstan, Dzhezkazgan, 5 June 1958, 1 ♂. Abkhaziya, Sukhumi, 30 September 1932, 1 ♀ (V. Belizin). Tadzhikistan, Kondara, 20 September 1945, 1 ♂ (V. Gussakovskiy).

28. Melanips parvus Hartig.

Chelyabinsk prov., Miass, Ilmenskiy Reservation, 14 July 1958, 1 ♂ (V. Tobias).

29. Melanips alienus Giraud.

Kursk prov., Tim, August 1959, from aphids on thistles, three ♀♀ and 1 ♂ (V. Belizin). Belgorodskaya prov., Urazovo, taken by the author from the following aphids in July 1947: 1 ♀ from Macrosiphoniella absinthii L. on Artemisia absinthium L.; three ♂♂ and three ♀♀ from Aphis saliceti Kalt. on Salix sp.; two ♂♂ and eight ♀♀ from Chromaphis mira Mordw. on Arctium tomentosum Schr., from which one ♀ was also collected by N. Krepakov on 16 August 1946.

Chelyabinsk prov., Miass, Ilmenskiy Reservation, 15 August 1958, one ♀ (V. Tobias). Kazakhstan, Kent Mountains, Karagandinsk prov., 25 July 1957, one ♀ (V. Tobias); Zhana Arka, 12 June 1958, one ♀ (V. Tobias). Georgia, Bakuriani, 16 July 1958, one ♀ (V. Tryapitsyn). Armenia, Vedi, 7 May 1957, one ♂ (V. Tryapitsyn).

30. Zygosis lucidus V. Belizin, sp. nov.

♀. Head and thorax dark brown; abdomen light reddish brown.

Head slightly shiny, delicately shagreened above;

face covered with striae spreading fanwise from clypeus, which is brown, very small and narrow, with a few wrinkles. Mandibles light brown. Antennae have fourteen segments, the first four yellow, the rest darker, brown and hairy, the third curved and somewhat longer than the fourth and the last four and a half times longer than the last but one.

Thorax coriaceous, almost mat, very slightly shiny, including the mesopleura, which are entirely aciculate. The metapleura, like the propleura, mat and coriaceous. Median segment delicately coriaceous, bare, mat, including the central area, which is narrow above and widens lower down.

Mesonotum, like pleura, delicately coriaceous and slightly shiny. Parapsidal grooves obvious over their whole length. Scutellum oblong-ovate slightly convex and of the same sculpturing as the mesonotum; pits smooth, small, narrow and transverse.

Wings transparent, with short cilia. Third branch of subcosta and first branch of radius strongly curved, second branch of radius quite straight. Radial cell prolate, three times longer than its width. Cubitus and media pale but distinct.

Abdomen smooth, shiny and longer than the head and thorax combined.

Body length 1.2 mm.

Holotype: Tadzhikistan, Stalinabad, 3 June 1934, 1 ♀ (Ye. Luppova).

Differs from Z. urticeti (Dahlb.) in that the ♀ has 14-segmented antennae and lighter coloration over the entire body.

31. Figites scutellaris Rossi.

Newly found in the following localities:

Kursk prov., Bol'shesoldatskoye, 12 August 1957, 1 ♂ (V. Belizin); Kursk, 29 July 1957, two ♂♂ and 1 ♀ (V. Belizin). Krasnodar region (kray), Maykop, 8 August 1953, three ♀♀ (V. Belizin); Sochi, 1957, one ♀ (Shishov). Irkutsk prov., Tayshet, 10 August 1944, one ♂ (V. Barovskiy); Mel'nikovo, 20 July 1912, one ♀ (A. Zav'yalova). Mongolia, Kiran, I Khaydon, 6 August 1908, one ♀ (Khomze).

32. Figites striolatus Hartig.

Kursk prov., Belaya, 30 May 1958, one ♂ (V. Belizin). Yakutiya, Yakutsk, 24 July 1927, one ♀ (Moskvin). Mongolia, Ulan-Bator (Urga), 22 May 1925, two ♂♂ (P. Kozlov).

33. Figites anthomyiarum Bouche.

Vologodskaya prov., Nelazskoye, Cherepovets district, 8 September 1935, one ♀ (V. Belizin). Stavropol'sk region, Zolotarevka, 24 May 1927, one ♀ (V. Belizin). Kaliningrad prov., Rybachiy settlement, 31 July 1958, one ♀ (M. Nikol'skaya).

34. Figites fuscinervis Giraud.

Kazakhstan, L. Zharkul, Akmolinsk prov., 10 June 1957, one ♀ (V. Tobias); Kokshetau, 7 June 1958, one ♂, one ♀ (V. Tobias); Shabdara, 21 June 1957, one ♀ (V. Tobias). Dzhezkazgan, Karagandinsk prov., 25 June 1958, one ♂ (V. Tobias). Yakutiya, Oy-Bes', Pavlovskoye village, 28 June 1925, one ♂, one ♀ (V. Biakin). Armenia, Kafan, 8 September 1956, one ♂ (V. Tryapitsyn).

35. Figites consobrinus Giraud.

New species in USSR fauna.

Kazakhstan, L. Zharkul, Akmolinsk prov., 11 June 1957, one ♀ (V. Tobias); right bank of r. Ural opposite Inderborstroy, Gur'yevskaya prov., 3 May 1951, one ♀ (L. Arnoldi). Tadzhikistan, Stalinabad, Botanical Gardens, 11 June 1944, one ♀ (V. Popov). Kaliningrad prov., Rybachiy settlement, 6 August 1958, one ♂ (M. Nikol'skaya).

36. Figites apicalis Giraud.

New species in USSR fauna.

Kursk prov., Kastornaya, 16 July 1936, one ♀ (V. Belizin). Irkutsk prov., Tayshet, 10 August 1944, one ♀ (V. Barovskiy); Padun-on-Angara, 1867, two ♀♀ (A. Chekanovskiy). Tadzhikistan, Kalay-Vamar, Rushan, 14 July 1915, one ♂ (Lazdin). Mongolia, Shara-Khada, Ulan-Bator (Urga), 21 July 1905, one ♂ (P. Kozlov); Ulan-Bator (Urga); 1 June 1925, one ♀ (P. Kozlov).

37. Figites nitens Hartig.

Kaliningrad prov., Rybachiy settlement, 20 July 1958, one ♀ (M. Nikol'skaya).

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Kursk Board of Agriculture

THE TAXONOMY OF ICHNEUMON WASPS OF THE TRIBE OPHIONINI (HYMENOPTERA, ICHNEUMONIDAE)

G. A. VIKTOROV

In working on specimens of the genus Ophion F. in the collections at the Moscow University Zoological Museum and the Institute of Zoology (USSR Academy of Sciences), I have found a number of specimens belonging to the genera Simophion, Clistorapha and Boethoneura, described by Cushman (1947) on the basis of material found in the arid regions of N. America. In clarifying the taxonomic position of these forms it was inevitably necessary to make some study of other genera of the tribe Ophionini and to some extent supplement and modify Cushman's generic diagnoses. This paper contains the results of the work indicated.

It is my pleasing duty to express deep appreciation to Dr. H. Townes of the University of Michigan Zoological Museum, for his kindness in sending me North American representatives of the genera mentioned above, and to V. V. Popov of the Institute of Zoology (USSR Academy of Sciences) and A. N. Zhelokhovets, of the Moscow University Zoological Museum, for granting me facilities to work on the collections and for valuable advice.

In his generic revision of the ichneumon-flies of the tribe Ophionini, Cushman describes a number of new genera, similar to Ophion but with the difference that the base of the radius is thickened and curved. While working on the Ophionini material in the collections mentioned above, I found representatives of some of these genera among the fauna of the USSR. On the other hand, it was noted long ago that the radius has a basal thickening in some Ophion species: O. parvulus Kriechbaumer (1879), O. pravinervis Kokujev (1906), O. boguschi Meyer and O. telengai Meyer (1935). These considerations made it necessary to study representatives of the various Ophion species and of related genera in order to discover how much foundation there is for classifying the latter as discrete genera.

The research showed that the genera Eremotylus, Simophion, Clistorapha and Boethoneura differ by a number of characters from Ophion. A characteristic feature of the wing venation in these genera is that the radius is basally thickened and curved (Figs. 1, 2, 3, 4), whereas no such curvature is observed among the Ophion species even when the radius is thickened (Fig. 5). Moreover, in all the genera mentioned above, a uniform curvature of the discocubital vein, an absence of lateral branching and a parallel arrangement of the proximal part of the discocubital and basal veins are typical features, whereas in most Ophion species these veins converge in direction of the costal margin of the wing, while the discocubital vein is fractured and has lateral branching (Fig. 6). Some species are exceptions to this rule (O. mirsa Shestk., O. buchariensis Meyer), but in these the radius is not thickened or curved at the base (Fig. 7). There are interesting differences in the thorax. In all genera of the Ophion group there is a gradual movement of the proximal part of the median segment towards the postnotum,[1] although the manner of this varies from one genus to another.

In representative of Ophion two lateral protuberances have developed at the base of the median segment, running forward and reaching almost to the postscutellum, with a depression between them (Fig. 8). A similar development could be observed in most of the species I studied (O. luteus L., O. impressus Thunb., O. internigrans Kok., O. semipullatus Kok. and others). In some species the median segment has moved up to the postscutellum over its entire length, so that the fovea at its base is either very small (as in O. buchariensis Meyer) or has disappeared altogether (O. telengai Meyer).

This is not so in the other genera. In contrast to Ophion, the postnotum in these often remains exposed over its entire extent but longitudinal lateral thickenings, joined posteriorly to the median segment, have developed on its surface (Figs. 9, 10, 11). Even in these cases we often find the median segment moving up to the metathoracic postnotum, but in a straight line, without protuberances.

All this provides cogent reason for separating Eremotylus, Clistorapha, Simophion and Boethoneura from Ophion. Of the Ophion species which have a distinct basal thickening of the radius, O. boguschi Meyer should be classified as belonging to the genus Boethoneura; the others (O. pravinervis Kok. and O. telengai Meyer) must be kept in their present taxonomic position, which is fully justified when all the characters are considered together.

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[1] As I have previously noted (Viktorov, 1957), Cushman erroneously includes this sclerite in the median segment and calls it a basal narrowing of the latter.

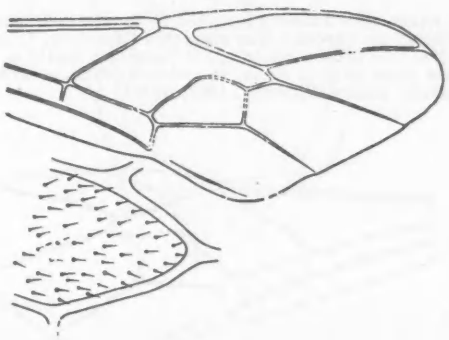

Fig. 1 - Eremotylus marginatus Jur., forewing: a - apex of discocubital cell.

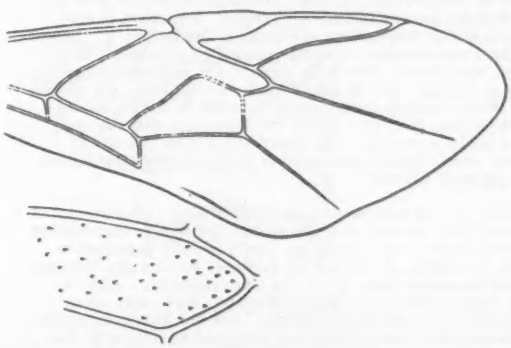

Fig. 2 - Simophion calvus, sp. n., forewing: a - apex of discocubital cell.

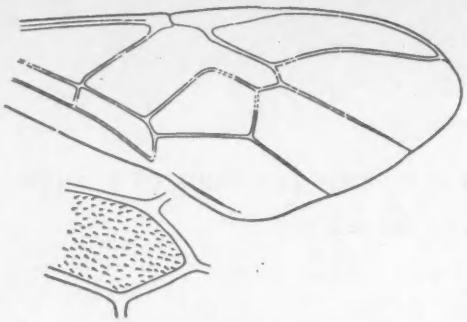

Fig. 3 - Clisterapha ventosa, sp. n., forewing: a - apex of discocubital cell.

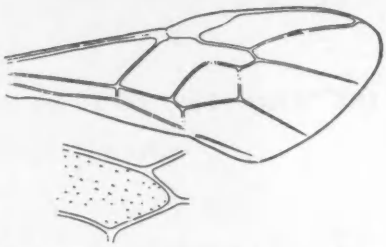

Fig. 4 - Boethoneura boguschi Meyer, forewing: a - apex of discocubital cell.

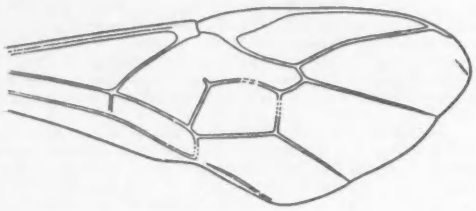

Fig. 5 - Ophion pravinervis Kok., forewing.

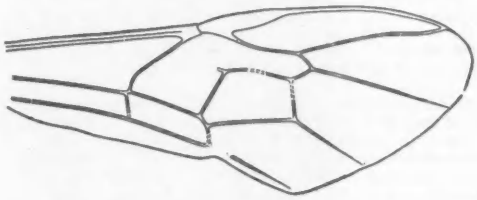

Fig. 6 - Ophion impressus Thunb., forewing.

There is also every justification for Cushman's (1947) restoration of generic independence for Stauropoctonus bombycivoros Gr., which Szepligeti (1905) included under Eremotylus, where Meyer (1935) left it.

The position of the genus Apatophiion merits discussion. This was described by Shestakov (1926) on the basis of a new species, A. mirsa, from Iran. Later, Meyer (1935) included it under Ophion. Cushman (1947) indicated agreement with this view in his generic revision of Ophionini, but changed his mind in a footnote added later, and on the basis of studying Hellwigiella similis Szepl. came to the conclusion that these species were related; he therefore included A. mirsa in the genus Hellwigiella. I was able to study the A. mirsa type specimen, along with other specimens of this species which have been subsequently collected in Turkmenia and Tadzhikistan. In addition, I came across specimens of a Hellwigiella species very closely resembling H. nigripennis Szepl. among the collections of N. Zarudniy from southwest Iran. The structural characteris and coloration fit the description perfectly, except that according to the description the mesopleural sculpturing is smooth, whereas in the specimens I studied the mesopleura were smooth only in the upper half and delicately rugulose in the lower half. On comparing the species mentioned I became convinced that they belonged to different genera. All the important characters (absence of postpectoral carina, presence of lateral pits at the base of the second abdominal tergite, structure of the mandibles and of the median segment) indicate that A. mirsa is a typical representative of the genus Ophion, and with regards the structure of the male genitalia it resembles Ophion impressus Thunb. On the other hand, the Hellwigiella species studied differ sharply from Ophion species in having a postpectoral carina, laterally margined scutellum and coarsely rugose median segment. The other representative of the tribe they most closely resemble is Barytatocephalus Schulz (=Barycephalus Brauns).

Meyer, in his well-known revision (1935), follows Szepligeti (1905) in including the genus Hellwigia Gravenhorst in the tribe Ophionini. Cushman (1947) is fully justified in opposing this although, following Townes, he inclines to class this peculiar genus under the tribe Campoplegini. After a cursory comparison of Hellwigia elegans Grav. with some representatives of the Campoplegini I am obliged to disagree with this opinion. Apart from the aberrant structure of the antennae and the venation, Hellwigia differs from the Campoplegini in having a single syntergum on the apex of the male abdomen, instead of paired syntergites as in the Campoplegini, and a peculiar structure of the subgenital plate, the basal ring of the phallobase[2] and the volsellae digitus. On these grounds there seems most reason to classify Hellwigia as a separate tribe, following Schmiedeknecht (1908) and, later, Sedivy (1956).

The position of the genus Stenophthalmus, described by Szepligeti (1905) on the basis of two species from Siberia and Algeria, remains obscure. Shestakov (1926) adds a third species, S. andalusiacus Shest., from Spain. An examination of the type specimen showed that this species is a typical representative of Ophion, with a strongly bulging head, reminiscent of the Central Asian Ophion cephalotes Meyer. Meyer (1935) associates it with Barycephalus Brauns. The status of this genus cannot be finally settled without study of S. algiricus and S. sibiricus Szepligeti; unfortunately, I did not manage to make such a study.

To cover all genera of the tribe Ophionini occurring in the fauna of the USSR I must say a few words about Coracophion Shestakov. This genus was wrongly included by Meyer (1935) among the Anomalonini (Therionini). Cushman (1947) has with good reason classified it as a member of the Ophi-

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[2]Although a different terminology for the male genitalia of insects has recently been suggested (Michener, Glossary, 1956), the older terminology of Snodgrass (1941) is used in this paper so as to preserve continuity with the author's earlier papers (Viktorov, 1957, 1958).

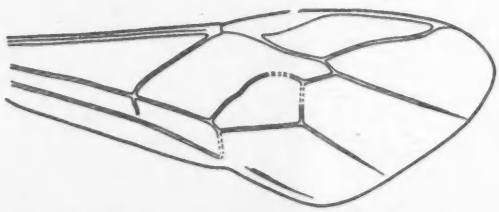

Fig. 7 - Ophion buchariensis Meyer, forewing.

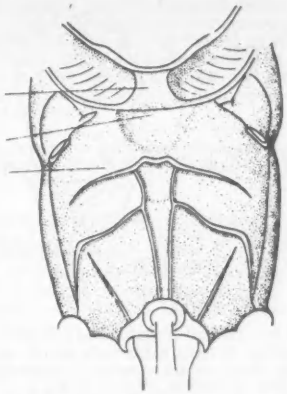

Fig. 8 - Ophion impressus Thunb., apex of thorax from above: a - postscutellum, b - postnotum, c - median segment.

onini and established its identity with Aglaophion Cameron.

Altogether, there are now nine genera of the tribe Ophionini known to occur among the fauna of the USSR. A recognition key is given below. It seems that the merging of the two apical abdominal tergites into one syntergum in the male and the unbroken basal ring in the male genitalia, which I observed in all the genera studied, should be taken as characters common to all representatives of the tribe (the males of Aglaophion and Stauropoctonus remain unknown to me).

1 (4). Pterostigma very narrow, gradually passing distally into the costal margin of the wing; longitudinal depression in the middle part of the mesopleura.

2 (3). Apex of clypeus bent upwards; mandibles not twisted on a longitudinal axis, so that their teeth are set one above another; occipital carina developed; second trochanter of hind leg lacks apical denticle.....
.....Aglaophion Cameron (= Coracophion Shestakov).

3 (2). Apex of clypeus not bent upwards; mandibles twisted on a long axis so that their teeth lie in a horizontal plane; no occipital carina; second trochanter of hind leg has a sharp denticle at apex .. Stauropoctonus Brauns.

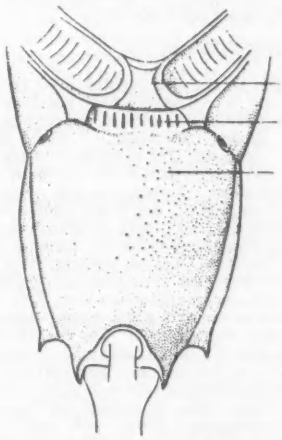

Fig. 9 - Simophion calvus, sp. n., apex of thorax from above: a - postscutellum, b - postnotum, c - median segment.

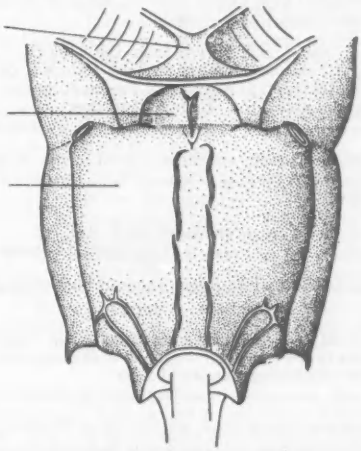

Fig. 10 - Clistorapha ventosa, sp. n., apex of thorax from above: a - postscutellum, b - postnotum, c - median segment.

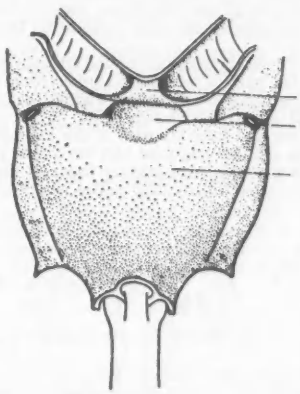

Fig. 11 - Boethoneura boguschi Meyer, apex of thorax from above: a - postscutellum, b - postnotum, c - median segment.

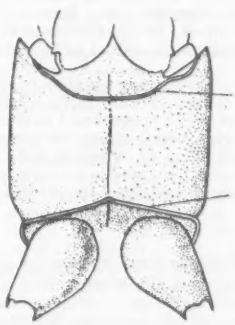

Fig. 12 - Clistorapha ventosa, sp. n., ventral surface of mesothorax: a - prepectoral carina, b - postpectoral carina.

4 (1). Pterostigma broad, narrowing abruptly on transition to costal margin of wing; no longitudinal mesopleural depression.

5 (6). Mandibles narrow abruptly towards apex; prothoracic sinus[3] narrow; spiracular sclerite not exteriorly visible; a small fenestra, the surface of which may or may not bear scleromes, apically on discocubital cell..... .....Enicospilus Stephens.

6 (5). Mandibles narrow slightly towards apex; prothoracic sinus broad; spiracular sclerite exteriorly visible; no fenestra apically on discocubital cell.

7 (10). Base of radius not angularly curved and in most cases not thickened (Fig. 6); when it is (Fig. 5), the base of the discocubital and the basal vein converge toward the anterior margin of the wing.

8 (9). Simple eyes small, set at a distance from the compound eyes several times greater than their diameter; developed postpectoral carina..... .....Barytatocephalus Schulz (= Barycephalus Brauns).

9 (8). Simple eyes large, their distance from the compound eyes not greater than their diameter; postpectoral carina lacking..... Ophion Fabricius.

10 (7). Base of radius in forewing thickened and angularly curved; discocubital vein evenly curved, its base parallel with the basal vein (Figs. 1-4).

11 (12). Radial cell short, a long way from the wing tip (Fig. 2); prepectoral carina more or less reduced, developed only on the ventral surface of the mesothorax and lacking on the sides, or lacking altogether..... ..... Simophion Cushman.

12 (11). Radial cell not short, reaching almost to the wing tip or slightly distant from it (Figs. 1, 3, 4); prepectoral carina fully developed.

13 (14). Postpectoral carina pronounced (Fig. 12)..... ..... Clistorapha Cushman.

14 (13). No postpectoral carina; slight rugosity sometimes replaces it.

15 (16). Long, densely set hairs on wing (Fig. 1, a); scutellum entirely margined; median segment with sharp carinae and coarse longitudinal rugae at apex..... .....Eremotylus Foerster.

16 (15). Wing hairs short and much sparser (Fig. 5, a); scutellum immargined or margined only at the base; median segment more delicately sculptured; sometimes with no carinae at all.....Boethoneura Cushman.

For reasons of space I shall limit myself to detailed descriptions of only those genera which have been found among the fauna of the USSR for the first time and to such additional data on other genera as are essential for diagnoses.

Genus SIMOPHION Cushman

Head. Simple eyes large, set at a distance from the compound eyes not greater than their own diameter; occipital carina complete; clypeus short, its apex truncated, sometimes concave; labrum protruding beyond apex of clypeus.

Thorax. Prothoracic sinus open, disclosing spiracular sclerite; ventral surface of mesothorax[4] lacks postpectoral carina and has a greatly reduced prepectoral carina (usually only on ventral surface, sometimes absent altogether); no carinae on median segment (Fig. 9), which is flat, gradually descending from base to apex, its base not reaching the postscutellum and leaving exposed a strip of the metathoracic

[3]The sinus is a cleft behind the superoposterior angle of the pronotum at the base of the wing (Cushman, 1947; Viktorov, 1957).

[4]Since the appearance of Richards' paper (1956) confirming the existence of cryptosterna in the mesothorax of most Hymenoptera the term mesosternum should be rejected in designating the ventral surface of this segment formed by the expanding mesopleura.

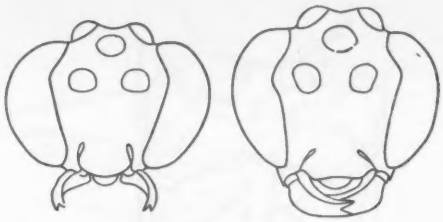

Fig. 13 - Head from in front: a - Boethoneura boguschi Meyer, b - Simophion calvus, sp. n.

postnotum on which two lateral longitudinal elevations have developed. Wings (Fig. 2) have extremely short and sparse hairs, so that their surface looks completely bare; the radial cell is more or less shortened and a good distance from the wing tip; base of radius very much thickened and angularly curved; discocubital vein almost parallel with basal, in its proximal part, evenly curved and without lateral branching; claws densely toothed.

Abdomen. Second tergite with distinct lateral pits at base; its spiracles set medially or slightly beyond the middle; in the male genitalia the parameres are joined dorsally, with a distinct suture between them.

Simophion calvus Viktorov, sp. n.

Simple eyes large, set slightly apart from compound eyes (Fig. 13, b), which have a deep notch on the inner orbits. Face slightly constricted at the bottom, shining, with very delicate, sparse punctation. Clypeus short, with anterior margin concave. The temples are rounded and narrowed behind and a good deal narrower than the diameter of the compound eyes. Antennae slender, setaceous, with 50-53 flagellar segments, and much longer than half the body. Mesonotum shining, with delicate punctation and the parapsidal grooves just perceptible anteriorly. Scutellum immargined. Delicate, sparse punctation on mesopleura, the distances between the punctures being greater than their diameter; the interpunctural spaces slightly shagreened, more noticeably so under the speculum, where the punctation also becomes more dense. The median segment (Fig. 9) almost completely smooth; straight, longitudinal rugae on the metathoracic postnotum. Pterostigma (Fig. 2) broad, narrowing abruptly where it passes into the costal margin of the wing. Base of radius curving away very close to the pterostigma. Radial cell very much shortened and remote from wing tip, its length along the costal margin almost equal to that of the pterostigma. Discocubital vein slightly undulated. Nervulus oblique, sharply antefurcal; fracture point of nervellus sometimes above, sometimes below the middle. A comb of close-set long teeth on leg claw.

Abdomen twice as long as head and thorax combined. Apical margin of last abdominal tergite curves inwards, partially screening the anal indentation (Fig. 14).

Color rust-brown with abundant pale yellow markings. The greater part of the face and the frontal margins, the vertex, the temples, four longitudinal bands on the mesonotum which merge anteriorly into pairs, the scutellum, the anterior and inferior part of the mesopleura, the apical part of the median segment and the distal parts of the abdominal segments (particularly those of the posterior segments) are all light in color. The wings are colorless, with

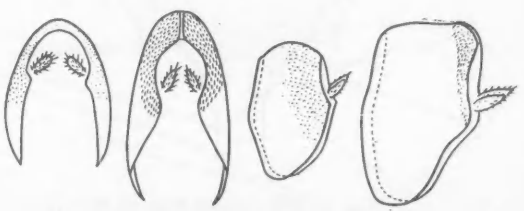

Fig. 14 - Apex of male abdomen: Boethoneura boguschi Meyer (a - from behind; c - profile) and Simophion calvus sp. n. (b - from behind; d - profile).

brownish venation and pterostigma, which is basally light-colored. The light markings vary greatly; they are most strongly developed in the specimens of more southern origin (Iran), occupying the entire face, almost the whole mesopleural area, the median segment and the greater part of the abdominal segments; the dark component of the coloration too is lighter-toned.

Body length 15-16 mm. Male similar to female except that the comb formed by the denticles on the leg claws is denser.

Turkmenia: Repetek, 8 September 1938 (1 ♀, holotype); 16 October 1938 (3 ♀♀); 20 October 1938 (1 ♀); 23 October 1938 (2 ♀♀): 26 October 1938 (1 ♀, paratype; Vinogradov); Aral'sk, 27 September 1932 (1 ♀; Bening); Iran: Farat, 27-29 October 1903 (1 ♂, allotype and 5 ♀♀; Zarudnyy). Types in Leningrad collection of Institute of Zoology (USSR Academy of Sciences).

Genus CLISTORAPHA Cushman

Head. Compound and simple eyes large, the former having a deep indentation in the inner orbits; occipital carina well developed throughout. Mandibles slightly narrowed towards the apex; labrum protruding beyond clypeus.

Thorax. Prothoracic sinus broad, spiracular sclerite visible exteriorly. Well developed pre- and postpectoral carinae on ventral surface of mesonotum (Fig. 12). Median segment more or less remote from postscutellum, leaving the metathoracic postnotum exposed; the latter with two lateral longitudinal elevations, joined caudally to the median segment (Fig. 10). Short but densely set hairs on wings (Fig. 3). Radial cell greatly elongated, almost reaching the wing tip. Base of radius thickened and angularly curved. Discocubital vein parallel with basal at its base, evenly curved, without lateral branching. Leg claws with a comb of long, close-set teeth, the same in both sexes.

Abdomen. Second segment with distinct lateral depressions at base, its spiracles being situated slightly beyond the middle. The abdomen rather large, two and a half times as long as the head and thorax combined. The parameres in the male genital apparatus dorsally joined but with a distinct suture between them.

Clistorapha ventosa Viktorov, sp. n.

Ocelli almost adjoin compound eyes. Antennae slightly shorter than body, with 49-53 flagellar segments. Face much constricted below (Fig. 13, a) and shining, with very delicate punctation. Clypeus oblong, roughly one and a half times wider than long. Distinct parapsidal grooves on mesonotum. Scutellum immargined. Mesopleura delicately but thickly punctate (distance between punctures being not greater than their diameters); punctation in the median part usually rugulose. Median segment (Fig. 10) drawn well back from postscutellum, its surface rugulosely punctate. The number of carinae varies greatly: at most, there are two longitudinal and two transverse carinae; the anterior transverse carina, however, is often lacking or rudimentary; in extreme cases only the posterior transverse carina is present, and that only developed laterally. Wings colorless; nervulus slightly antefurcal or interstitial, nervellus fractured a little below the middle. Color rusty red, more reddish in the Armenian specimens and more brownish in the Turkmenian. Anterior and posterior eye orbits, and in the Turkmenian specimens the greater part of the face and the temples, pale yellow. Length 14-16 mm.

W. Kopet-Dag, Mt. Syunt, northern slope, 12 May 1953, in daylight (2 ♂♂ - holotype and paratype; 4 ♀♀ - allotype and paratypes; Shteynberg); Belab, Nakhichevan ASSR, 24 May 1957 (2 ♂♂; Zagulyayev); Alushta, s. bank of Krym, 13-15 May 1900 (1 ♀; Kuznetsov); Kirgizia, Dzhalalabad prov., Karavansk distr., 21 May 1952 (1 ♀; Mints). Type in Leningrad collection of Institute of Zoology.

Genus BOETHONEURA Cushman

Head. Compound and simple eyes large, the former with a deep indentation in the inner orbits. Occipital carina complete. Labrum protrudes beyond clypeus.

Thorax. Prothoracic sinus open, spiracular sclerite visible exteriorly. Parapsidal grooves perceptible only in front; scutellum immargined or margined only at the base. Prepectoral carina well developed; no postpectoral carina. Median segment (Fig. 11) more or less remote from postscutellum, leaving a continuous strip of the metathoracic postnotum exposed; on this there are two lateral longitudinal elevations joined dorsally to the median segment. The surface of the median segment may have carinae, of various degrees of development, or none at all. The wing surface covered with short, fairly sparse hairs (Fig. 4, a); radius thickened and basally curved (Fig. 4). Pterostigma broad, discocubital vein parallel with basal vein and evenly curved, sometimes with traces of lateral branching. Radial cell prolate, at some distance from wing tip. Leg claws with a comb of close-set, long teeth, equally dense in both sexes. Abdomen twice as long as head and thorax combined; second abdominal tergite with distinct lateral depressions basally, its spiracles being situated slightly beyond the middle. In the male genitalia the parameres are joined dorsally, with a distinct suture between them.

Boethoneura boguschi (Meyer) (new combination) (=Ophion boguschi Meyer).

Ocelli large, almost adjoining compound eyes. Face very much narrowed below, delicately but densely punctate. Antennae almost as long as body, with 47-48 flagellar segments. Clypeus oblong, roughly one and a half times as wide as it is long. Mesonotum shining, almost smooth. Scutellum immargined. Mesopleura closely punctate, the distance between the punctures being not greater than their diameter, with close, rugulose punctation under the smooth, shining speculum. No carinae on surface of median segment (Fig. 11); a few weak longitudinal rugae apically; punctation rugulose. Wing surfaces covered with short, fairly sparse hairs (Fig. 4, a). No trace of lateral branching on discocubital vein. Nervulus varying from interstitial to clearly postfurcal. Nervellus fractured in varying degrees below the middle. Color rust-red; temples and wide strips along anterior and posterior eye orbits pale yellow. Length 10-11 mm.

Turkmenia: Uzboy, sands at Topyatan, 23 April 1951, in daylight (6 ♂♂; Shteynberg); nr. Iskander stn., 6 April 1951 (1 ♀; Kryzhanovskiy); nr. Kizyl Arvat, 18 April 1951 (1 ♀, Kryzhanovskiy); 40 km north of Kizyl-Arvat, 2 May 1953 (2 ♀♀; Panfilov); Toutly, 35 km northeast of Kizyl-Arvat, 10 April 1952 in daylight (1 ♂; Romadina); Archman, 15 May 1923 (1 ♀; Rohdendorf); Uch-Adzhi, 13 April 1900 (1 ♂; Germs); Repetek, 24 April - 7 May 1914 (2 ♂♂; Plavil'shchikov). Uzbekistan: Shakhimardan, Fergana prov., 14 June 1900 (1 ♂; Germs).

All three species described above (Simophion calvus, Clistorapha ventosa and Boethoneura boguschi) are interesting from a zoogeographical standpoint in that they belong to genera peculiar to the arid regions of the Old and New Worlds and are thus analogous to certain plants (Ephedra, Fagonia, Eurotia, Peganum and others) believed by some botanists (Il'in, 1946) to be elements of the ancient Mediterranean desert flora. The same may be true in the case of representatives of the genera Simophion, Clistorapha and Boethoneura, which are far less numerous among the desert fauna of Soviet Central Asia than such flourishing and richly represented genera of ichneumon flies as Ophion, Enicospilus and Paniscus, which would seem to be younger inhabitants of the deserts.

Genus EREMOTYLUS Foerster

Head with a well-developed occipital carina. Ocelli large, adjoining compound eyes or at a distance from them not greater than their own diameter. Mandibles slightly narrowed apically.

Thorax. Prothoracic sinus broad, revealing spiracular sclerite. Prepectoral carina well developed, postpectoral carina lacking. Tubercles developed laterally on ventral mesothoracic surface (these are lacking in E. sibiricus Szepl.). Scutellum sharply margined to the apex. Median segment either very close to the postscutellum or well removed from it (E. hungaricus Szepl.) so that a continuous strip of the metathoracic postnotum is left visible. Surface of median segment with sharp longitudinal and transverse carinae and apically covered with coarse longitudinal rugae. Long, close-set hairs on the wings (Fig. 1, a); the base of the radius in the forewing thickened and curved (Fig. 1). The discocubital vein evenly curved, without lateral branching and with its proximal part parallel with the basal vein.

Abdomen. Second tergite with lateral depressions basally. In the male genitalia the parameres are joined dorsally, with a distinct suture between them.

According to Meyer's summary the genus is represented among the fauna of the USSR by only one species, E. sibiricus Szepl. Two other representatives are now known: E. marginatus Jur. and E. hungaricus Szepl , captured in the northern Caucasus by A. Alekseyev and myself.

Genus BARYTATOCEPHALUS Schulz. (Barycephalus Brauns, preocc.)

Distinguished from neighbouring genera in that the ocelli are small and set at a distance from the compound eyes several times greater than their diameter, the radius is neither thickened nor curved basally, there are pre- and postpectoral carinae, no lateral foveae at the base of the second abdominal tergite, and the scutellum is margined at least to the middle. In the male genitalia the parameres merge dorsally without a suture.

Barytatocephalus mocsaryi Brauns (= Barycephalus mocsaryi Brauns; Barycephalus seminiger Brauns, syn. n.; Ophion amoenus Tosquinet, syn. n.).

Brauns (1895) described the genus Barycephalus on the basis of two species from Hungary, one (B. mocsaryi) from the male, the other (B. seminiger) from the female, but did not exclude the possibility that these might actually represent the two sexes of a single species. Shestakov's description of the B. seminiger male (1926) is based on a misunderstanding, for the specimen in the Institute of Zoology collection identified by him as a male proved to be really a female, with the ovipositor concealed within the third valvulae. All the collections I have studied (my own from the Stalingrad province and those of V. N. Belyayeva and V. I. Tobias from Kazakhstan) contained only males of B. mocsaryi and females of B. seminiger. These considerations are sufficient grounds for treating these forms as a single species, B. mocsaryi.

In 1900 Tosquinet described a new species, Ophion amoenus, from a male specimen in Bekker's Sarepta collection. Comparing his description with the diagnoses of the genus Barycephalus and the species B. mocsaryi I am satisfied that the two are identical. The morphological features (bulging head, small eyes set well away from the base of the jaws, the absence of carinae on the median segment and so forth) and the quite characteristic coloration are completely alike.

Genus OPHION Fabricius

Cushman's diagnosis (1947) requires the further note that in some cases the radius is basally thickened (Fig. 5), although it is never curved. In addition, this character is not always present in combination with a parallel arrangement of the discocubital and basal veins. The median segment is moved up to the postscutellum either by two lateral protuberances with a fovea between them (Fig. 8) or in its entirety. In the male genitalia the parameres are joined dorsally, with a distinct suture between them.

Genus ENICOSPILUS Stephens

To supplement Cushman's diagnosis (1947), repeated by myself (Viktorov, 1957), it must now be added that the male genital parameres are dorsally joined (without suture); this distinguishes the genus from Ophion and closely related genera (Eremotylus, Clistorapha and Boethoneura).

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PALAEARCTIC FRUIT-FLIES (DIPTERA, TRYPETIDAE) OF THE GENUS RHAGOLETIS LOEW AND CLOSELY RELATED GENERA

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This group comprises the fruit-flies whose larvae infest fleshy fruits and are injurious to many useful plants in the temperate zone. The sour and sweet cherries and the honeysuckles are attacked by the European cherry flies Rhagoletis cerasi (L.), Rh. obsoleta Her. and Rh. almatensis Rohd., sp. n. (described from specimens found in Kazakhstan) and by the North American cherry flies Rh. cingulata Lw., Rh. indifferens Curran and Rh. fausta O.S. The American apple fly Rh. pomonella Walsh is an important subject of quarantine inspection; its larvae infest the fleshy fruits of many other plants besides apples, including the bilberries Vaccinium uliginosum and V. myrtillus. In North America the bilberries are also attacked by peculiar species of these fruit-flies, Rh. tabellaria Fit. and Rh. zephyria (Snow). Several species attack the fruits of various barberries (Berberis species); these include the European Zonosema meigeni Lw., the Asian species Z. kurentsovi Rohd., sp. n., Microrrhagoletis samojlovitshae Rohd., g. n., sp. n., Megarrhagoletis magniterebra Rohd., g. n., sp. n. (described below) and a North American species, Rh. berberis Curran. Larvae of the very common palaearctic species Zonosema alternatum (Fall.), the Asian species Z. turanicum Rohd., sp. n., (described below) and a North American species, Rh. setosa Doane infest rose hips. The larvae of Rh. flavigenualis Hering, a species recently described from specimens collected in Anatolia but also found in Caucasia and Tadzhikistan, and of a North American species, Rh. juniperina Marc., infest the berries of juniper and artemisia. In addition there are certain species in North America whose larvae infest the walnut pericarp (Rh. completa Cresson, Rh. juglandis Cress., Rh. boycei Cress.) and the berries of various species of currant (Ribes) (Rh. ribicola Doane).

With the exception of a few species (the European Rh. zernyi Hendel and Rh. batava Hering, the Asian Rh. reducta Hering and Rh. scutellata Zia and certain North American species) the habits of these larvae are now known.

The genus Rhagoletis, with other closely related genera, belongs to the tribe Trypetini Hering of the subfamily with the same name. They are closest to genera of the Carpomyia A. Costa complex on the one hand and to those of the Trypeta Meigen complex on the other. Some thirty species of the Rhagoletis group are known.

The types of the new species are in the Leningrad collection of the USSR Academy of Sciences Institute of Zoology.

Characteristics of the Group of Genera Related to Rhagoletis Loew (Alate Insects)

Description: Well developed frontal setae; three pairs of ori. Compound eye setae long and sturdy. Third antennal segment almost invariably (except in Z. kurentsovi Rohd.) has an acute superior distal angle. Arista hairy over a very short distance, otherwise almost bare. Frontal band as a rule has well developed hairs; more rarely, these are very sparse and almost invisible (Rh. flavicincta Lw.). A cluster of light setae on propleura; one posterior seta on sternopleura; there is a presutural seta; scutellum has four marginal setae; dc setae situated cephalad of the ac level and at the same level as sa.; middle tibia with one apical seta (spur) underneath; long setae on the front of the hind femora, basally and before apex. The radio-medial cross-vein in the middle or near the middle of the medial (discoidal) cell. Vein r_{4+5} has a few setae on the upper surface, though sometimes only at the very base, of its proximal branch.

Comparison: These genera are distinguished from Carpomyia A. Costa by the hairy frontal zone and the absence of shiny black patches on the mesonotum, and from Trypeta Meigen by the presence of sturdy setae on the anterior surface of the hind femora before their apices and by the pointed third antenna segment.

Distribution and taxonomy: Europe, palaearctic Asia, North America; one species is indicated as belonging to the mountainous part of South America. Four genera: Rhagoletis Loew, Microrrhagoletis Rohd., g. n., Zonosema Loew, Megarrhagoletis Rohd., g. n. The relationship of the nearctic genera Zonosemata Benjamin and Epochra Loew to this group are unknown to the author.

Key for Identification of the Genera

1 (2). Genae moderately bulging posteriorly, always narrower than half the eye length; eyes high and narrow; ovipositor very short, not longer than sixth tergite; thorax black, only humeri, notopleura and scutellum partly ligh; small, usually 2.5 to 3.5, occasionally up to 4.5 mm ..... Rhagoletis Loew (page 89).

2 (1). Genae bulging strongly posteriorly, where their width is never less than half the eye length; eyes lower and wider; ovipositor always longer than sixth tergite; lighter color, thorax not completely black ..... 3.

3 (4). Body smaller (2.5-3.5 mm); color almost wholly light yellow, except for dark patches on median abdominal tergites of female and thoracic notum of male; ovipositor short but sharply separated from circular abdomen ..... Microrrhagoletis Rohd. (page 95).

4 (3). Larger (3.5-7 mm); coloring varied, sometimes dark with light markings and pollen ..... 5.

5 (6). Ovipositor shorter than abdomen, barely distinct from sixth tergite in its thickness and width; male genitalia fairly large, cerci short, wide and flabellate; abdomen usually flattened, depressed ..... Zonosema Loew (page 96).

6 (5). Ovipositor very large, of the same length as the abdomen or longer, and cylindrical; male genitalia larger, cerci narrower and longer, protruding blade-like; abdomen cylindrical, partially laterally compressed, with distinct markings in the form of cross bands ..... Megarrhagoletis Rohd. (page 100).

Genus RHAGOLETIS Loew

Generic type — Musca cerasi L., 1758.

Short description: Posterior part of genae somewhat bulging, always shorter than half the eye length; the genae not very high. Lower edge of head straight or slightly convex. Eyes high. Head not particularly short in profile. Ovipositor (= 7th tergite) very short, not longer than sixth tergite, appreciably wider than long. Male genitalia small, with wide flabellate cerci; distal bulging section of phallosome large and bulky with membranous dentate plates on the end. Body dark-colored, the abdomen being always mainly

black.

Comparison: Distinguished from other genera by the large eyes, the slight bulge at the back of the head and the dark body color. The short ovipositor is also very characteristic. Owing to the lack of comparative material the interrelationships of the nearctic species of this genus and their relationship to species of the genus Zonosema are unknown to the present author.

Taxonomy and distribution: There are nine palaearctic species, which fall into two groups: 1) the smaller European and Asian species, which are relatively dark with thin pollen of lighter color (Rh. cerasi (L.), Rh. obsoleta Hering, Rh. flavicincta Lw., Rh. almatensis Rohd. sp.n., Rh. reducta Hering, Rh. scutellata Z. et Ch.); 2) the larger, Mediterranean species, which are light in color and have conspicuous pollen (Rh. zernyi Hendel, Rh. flavigenualis Hering, Rh. batava Hering). Over a dozen North American species are known, some of them clearly distinguishable from the palaearctic species by the wing markings (for example, Rh. pomonella Walsh and Rh. fausta O. -S), others with markings like those of Rh. flavicincta Lw., Rh. reducta Hering.

Key for Identification of Species

1 (4). Short, dark cross band on mid-wing, near anterior edge, in cells R_1 and R_3, not continuing back beyond vein R_3 ..... 2.

2 (3). All femora black; abdomen black, sometimes with narrow light bands on posterior margins of middle and hind tergites; third antennal segment 1 3/4-2 times as long as second. Larvae infest fruits or berries of sour and sweet cherries, honeysuckle and occasionally certain other plants. Europe, Central Asia..... ..... Rh. cerasi (L.) (page 90).

3 (2). Femora and tibiae light-colored except for the hind ones, which are slightly darkened in the middle; abdominal tergites with broad yellow marginal bands; third segment of antenna 1 1/3-1 1/2 times as long as second. Larvae infest honeysuckle berries. Southeast Kazakhstan..... Rh. almatensis Rohd., sp.n. (page 91).

4 (1). No short dark band in the middle of the wing; a colorless space without dark patches or bands between the second and third dark cross-bands; even these bands are sometimes interconnected by anastomosis..... 5.

5 (12). Femora of all pairs of legs dark-colored except at the ends, which are lighter..... 6.

6 (9). Dark apical band on wing along costal vein, barely leaving a light, colorless space along edge..... 7.

7 (8). Abdominal tergites with light bands on caudal margins. Food plant not known. Primorskiy region and China (Tungpei)..... Rh. reducta Hering (page 91).

8 (7). Abdominal tergites completely black. Larva in honeysuckle berries. Europe..... ..... Rh. obsoleta Hering (page 92).

9 (6). Dark apical band on wing separated from marginal vein by distinct colorless area along edge..... 10.

10 (11). Abdomen with narrow gray bands on caudal margins of middle tergites; genae fairly broad behind, almost half as long as the eyes. Food plant not known. Western Europe..... Rh. batava Hering (page 92).

11 (10). Abdomen entirely black, without light bands. Food plant not known. North China (Kangsu) ....Rh. scutellata Z. et Ch. (page 93).

12 (5). Fore and middle femora entirely yellow, hind femora sometimes slightly darker..... 13.

13 (14). Second and third dark cross-bands on wing merging in the region of cell R_3 and, partly, R_1; apical band abruptly separated from wing margin; all abdominal tergites with broad yellow bands on caudal margins. Food plant unknown. Spain. Rh. zernyi Hendel (page 93).

14 (13). Second and third wing bands always separated. .15.

15 (16). Body small (2.5-3.5 mm); apical cross band on wing along the very edge and not separated from it by a light space; abdomen with yellow bands on caudal margins of tergites; fifth (♂) or sixth (♀) abdominal tergite with well separated black circular patches against yellow background. Larvae infest honeysuckle berries. Europe and Central Asia..... Rh. flavicincta Loew (page 93).

16 (15). Larger (3.4-4.5 mm); apical wing band distinctly separated from edge by a light, colorless area; abdomen with four (♀) or three (♂) gray bands on posterior margins of tergites; fifth (♂) or sixth (♀) tergite with a dark yellow posterior border. Larvae infest juniper and artemisia berries. Caucasus, Anatolia, Tadzhikistan. .....Rh. flavigenualis Hering (page 94).

Description of Species

Rhagoletis cerasi L., 1758. Cherry fly (Fig. 1).

Hendel, 1927:75.

Short description and comparison: Differs from other species by the dark color of femora and presence of a short, dark, cross-band on mid-wing in cells R_1 and R_3. Fairly distinct, dark brown bands of surface pollen. Genae narrow. Male genitalia with characteristic straight, slender coxites, not curved back at the tips, evenly bulging at the dorsal edge and slightly, evenly concave at the ventral edge.

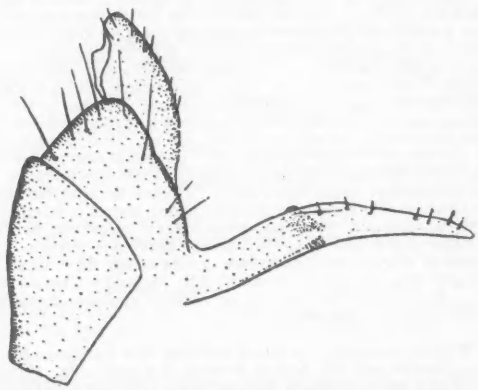

Fig. 1 - Rhagoletis cerasi cerasi (L.), male: genital and anal tergites, cerci and coxites (Voronezh prov., prep. 3037).

Variations and geographical distribution: The wing markings vary; sometimes the short middle band partially merges with the distal band along its anterior edge (ab. conjuncta, ab. n.) or at its posterior tip (ab. conjunctior, ab.n.). The color of the legs and abdomen has also been found to vary, though the latter has a more definite color which seems to be connected with the ecology and geographical distribution. It is therefore worth establishing geographical varieties or subspecies, which can be differentiated as follows:

1 (2). Hind tibiae, except the distal fourth, and last segments of all tarsi black. Abdomen completely black. North Tadzhikistan.....Rh. cerasi nigripes, ssp.n.

2 (1). All tibiae light instead of dark.....3.

3 (4). Posterior margins of middle tergites of abdomen more or less yellow .....Rh. cerasi fasciata, ssp.n.

4 (3). Abdomen completely black or with barely noticeable reddish-yellow markings on posterior margins..... .....Rh. cerasi cerasi L.

Rhagoletis cerasi nigripes Rohd., ssp. n. Apart from the peculiarities of leg coloration indicated in the key, the somewhat longer head (in profile the genae appear wider) and the very slight, barely noticeable pollen on the notum deserve mention. The wing markings are sharp and brown in color; the short median band on the middle of the wing is even, well demarcated and situated in the middle of the

space between the second and third cross-bands, which is fairly narrow. The food plant is not known. The description is based on a single female specimen from North Tadzhikistan (natural landmark Gurolash, 60 km from Zaamin, Turkestan range); collected in grass on 26 June 1947 (plot no. 3) (N. I. Fursov).

Rhagoletis cerasi fasciata Rohd., ssp. n. The male has four narrow but distinct yellow bands on caudal margins of second-fifth abdominal tergites; the female has, in addition, a fifth band on the sixth tergite and longitudinal light median bands on the sixth and on the posterior half of the fifth tergite. The light transverse bands are widest in the middle and narrow gradually towards the sides. The description is based on specimens collected from honeysuckle mowings in the province of Voronezh (Kamennaya Steppe; 2 ♂♂, 26 June 1949; 3 ♂♂, 25-26 June 1950. B. Vereshchagin), and the province of Stalingrad (Sarepta, 1872, 1 ♀, type, Bekker) and Western Kazakhstan (Yanvartsevo, right bank of the Ural River, 10 ♂♂ and 1 ♀ on 8 and 12 June 1950, K. Ya. Grunin). Food plant - honeysuckle (B. Vereshchagin's observation); the present author has no specimens taken from sweet or sour cherry. General distribution not entirely clear: the subspecies seems to occur in Western Europe as well, as Hendel's remark on the presence of light bands on posterior margins of abdominal tergites of Rh. cerasi indicates ("Abdomentergite seltener mit gelben Hinterrandssaeumen;" Hendel, 1927:76).

Rhagoletis cerasi cerasi (L.). Typical subspecies, characterized by absence of light bands on abdomen; sometimes only barely perceptible dark brown or chestnut-red, very narrow, marginal markings in the middle of the posterior edge of the fourth-sixth abdominal tergites in the female. This subspecies is known to the author from specimens collected in the provinces of Leningrad (near the city of Leningrad), Kirovo (Urzhum), Voronezh (Kammenaya Steppe), Orenburg (Verkhnyaya Dneprovka) and Western Kazakhstan (Yanvartsevo) and in the Crimean rayon, Northern Caucasia. There are also three females from Switzerland (Lutry) in the USSR Academy of Sciences Institute of Zoology. Overall distribution apparently wider than that of the preceding subspecies. Indications of food plant only in the case of the Kammenaya Steppe insects, which were reared from honeysuckle berries (Lonicera xylosteum L.; B. Vershchagin).

Ecology: The cherry fly is a serious pest and its habits have been fairly comprehensively studied (see summaries by Rohdendorf, 1936 and Hennig, 1954). The larvae live in the fruits of sweet and sour cherries and the berries of honeysuckle (Lonicera xylosteum L. and L. tataricum L.). There are also reports of the development of cherry fly larvae in the berries of Symphoricarpos albus L. (Hennig, 1954), Lycium barbarum L. (Hendel, 1927) and Berberis vulgaris L. (ibid), which all require verification through accurate investigation of the taxonomic characteristics of the insects obtained from the plants mentioned. In all probability such varied plants are also the nutrient substrate for quite other, taxonomically different forms of the same genus.

Rhagoletis almatensis Rohdendorff, sp. n. (Fig. 2).

Comparison: Near Rh. cerasi (L.), from which it is distinguished by the short third antennal segment, lighter color and certain other features.

Description: Third antennal segment pointed and only half as long as second; arista slender, with flattened base. Frons at level of superior ocular angles of same width as eyes or slightly wider; at level of base of arista much narrowed, especially in the male. Three, more rarely two ori; two ors, and dorsal being shorter than the ventral; vte half as long as vti. Frontal band covered with very short, sparse, black setae, which are more numerous in the females. Parafacials in narrowest part appreciably wider than base of arista. Genae not particularly narrow, their width (= height!) being roughly 3/4 the length of the third segment of the antennae, somewhat bulging behind. Notum has gray pollen in places, noticeable only when viewed slightly from the side and not forming any distinct longitudinal bands (or, if there are such bands, they are very broad and almost merge with one another). The wing is the same as in Rh. cerasi. The hind tibia has a row of sixteen setae on the anterior upper margin; these are short, their tips only just crossing (in Rh. cerasi they cross one another over more than half their length). In the female the fifth abdominal tergite is longer than the fourth and its edge is covered with sturdy setae; the sixth tergite is three fourths the length of the fifth and has marginal setae. The ovipositor (seventh tergite) is appreciably longer than the sixth tergite and shaped like a truncated cone. In the male the fifth abdominal tergite is the longest, being half as long again as the fourth; the cerci are shaped like a wide, protruding vane. The coxites become thinner and noticeably reclinate at the end. The body length is 2-3 mm.

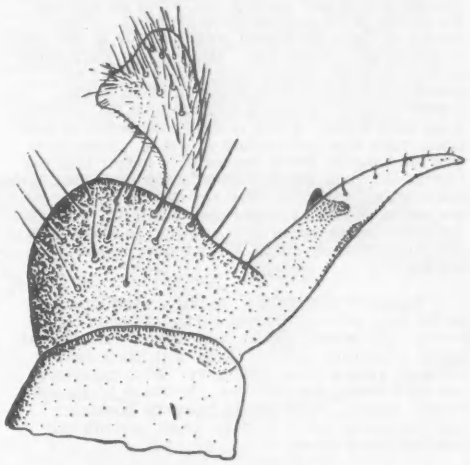

Fig. 2 - Rhagoletis almatensis Rohd., sp.n.: male: genital and anal tergites, cerci and coxites (Alma-ata area, cotype, prep. 3036).

The head is yellow, the facial disc and orbits light in color. The posterior surface of the head has a contrasting black patch in its upper half. The antennae are yellow, the arista dark-brown. The thorax is black and shining, the humeral tubercles, upper part of the mesopleura and wing bases contrasting white. Wing markings are the same as in Rh. cerasi. The halteres are light yellow. Legs are yellow; hind femora slightly darkened at the middle; sometimes traces of darkening on the middle and fore femora. The abdomen is black, with well developed markings in the form of light bands or patches on the caudal margins of the tergites. In the males the lateral margins, entire posterior third of the second tergite, the median band, posterior two-fifths and lateral margins of the third tergite, the median band, posterior third and lateral margins of the fourth tergite and the very narrow median band and posterior marginal border of the fifth tergite are all yellow; the markings on the fifth tergite are reddish. The anal tergite in the male is shiny black, the genital tergite, cerci and coxites light-colored. In the females the second to fourth tergites have light posterior marginal bands, which are wider on the anterior tergites; the fifth tergite has a very narrow reddish border on the posterior margin; there are no median bands; the sixth tergite has a wide (1/3 - 1/2 of its length) reddish border; the ovipositor (= seventh tergite) is black.

Distribution and material: The description is based on two males (type, Nos. 3036 and 3063) and two females (Nos. 3057 and 3062) from Alma-Ata, reared from larvae by M. N. Kandybina on 15 July 1957.

Ecology: The larvae infest honeysuckle berries (Lonicera tatarica L.).

Rhagoletis reducta Hering, 1936.

Hering, 1936:182.

Comparison: Near Rh. cerasi and Rh. flavicincta, differing from the former by the absence of the short intermediate median band in the middle of the wing, and from the latter by the black femora of the female. Easily identifiable by the evenly developed transverse, light bands on the posterior margins of the second to fifth abdominal tergites. Male not known.

Short description: Female. Third antennal segment pointed, three quarters as long again as second. Frons at level of superior ocular angles, somewhat narrower than eyes, narrowing only slightly in front. Genae fairly broad, somewhat bulging behind and roughly two thirds as high as the length of the third antenna segment. Parafacials at their narrowest point as wide as the base of the arista. Three ori. Many short, dark hairs on frontal band. Light-gray, dense pollen on notum, forming four broad longitudinal bands. Humeral tubercle, upper mesopleural margin and wing base white. A row of 8-10 long setae on hind tibia, their tips perceptibly crossing. Fifth tergite the longest, being appreciably longer than the fourth; the sixth short, only slightly more than half the length of the fifth. The seventh tergite (ovipositor) a good deal longer than the sixth, almost the same length as the fifth and shaped like a truncated cone. Body length 3.5-4.5 mm; wings 3.0-3.5 mm.

The head dark yellow, facial scutellum and genae light yellow. Dorsal surface of head black, orbits light behind, genae light throughout. Thorax black, scutellum yellow. Legs with black femora and light yellow tibiae and tarsi. Wing markings are dark brown and uniform. Abdomen black and brown, shining, with yellow bands on posterior margins of second to sixth tergites; seventh tergite black and brown.

Distribution: The species is described from material collected in Northern China (Tungpei: Harbin and Kirin) and is known to the present author from a single female from the Primorskaya province (Yakovlevka, Spassk district).

Ecology: Food plant not known.

Rhagoletis obsoleta Hering, 1936 (Fig. 3).

Rhagoletis cerasi forma obsoleta Hering, 1936: 182.

Comparison: Near Rh. cerasi, from which it is distinguished by the short median band on the wing and the structure of the genital coxites in the male.

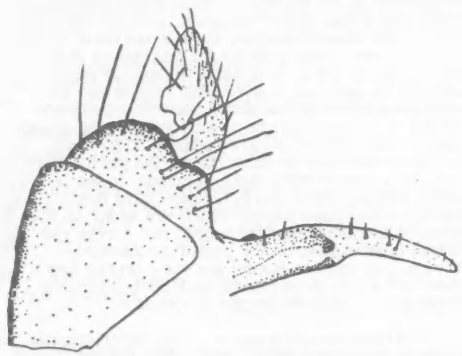

Fig. 3 - Rhagoletis obsoleta Hering, male: genital and anal tergites, cerci and coxites (Voronezh prov., prep. 3046).

Short description: Male. Third antennal segment 1 3/4-2 times as long as second, sharply pointed; arista with a conical thickening and covered with hairs, which are not particularly short. Frons between superior angles noticeably narrower than eyes; in its narrowest part it narrows abruptly and is not wider than one fifth the width of the head; two ori; vte less than half the length and thickness of vti. Frontal band with sparse, short, black hairs on anterior half. The parafacials at their narrowest are narrower than the arista. Genae not particularly narrow, their height being equal to half the length of the third antennal segment, and moderately bulging behind. The notum with two median, fairly distinct bands of grayish pollen and lateral patches of similar pollen in front of the suture. Wings as in Rh. flavicincta Lw. A row of five or six not particularly long setae on anterior upper margin of hind tibia, their tips only just crossing. In the male the fifth abdominal tergite is three quarters as long again as the fourth. Genitalia like those of Rh. cerasi; coxites slender and curved, with a characteristic indentation in the middle and no curvature at the end. Body length 3 mm.

Head dark yellow, facial disc slightly lighter. Posterior surface of head, including posterior parts of genae, black right up to the edge of the mouth. Antennae dark yellow, arista brown. Thorax colored as in Rh. cerasi. All femora completely black, tibiae and tarsi yellow. Wing markings dark brown; colorless space between second and third bands narrow. Abdomen completely black, without light bands.

Distribution and material: Described on the basis of material from Western Europe; known to the author from a single male from the Voronezh province (B. Vereshchagin, 25-26 July 1950).

Ecology: Feeds on honeysuckle.

Rhagoletis batava Hering, 1958.

Hering, 1958:2.

Comparison: A peculiar species, clearly distinguished from others by its broad genae and the bulging posterior surface of the head when viewed from below. The wing markings are not unlike those of Rh. flavigenualis Hering and Rh. flavicincta Loew.

Short description: Female. Third antennal segment more than twice as long as second, sharply pointed at the end. Arista thickened at base and covered with short hairs. Frons appreciably wider than eyes between superior ocular angles, its length barely greater than its width; at its narrowest the frons roughly a quarter the width of the head. Three ori; vte slightly shorter than vti. Frontal band covered with sparse black hairs. Parafacials at their narrowest narrower than half the width of the third antennal segment but considerably wider than the thickness of the arista. Genae relatively broad (3/4 the length of the third antennal segment and roughly one sixth the height of the eyes, passing at the back into the fairly strongly bulging surface of the head. Notum with four longitudinal bands of gray pollen: these are of uniform width; the black space in the middle roughly twice as wide as the lateral spaces. The dc setae are at the same level as the sa. Wing markings as in Rh. flavicincta; space between second and third bands narrower than width of second band; apical dark band separated from wing margin by a wide colorless space situated in cells R_1, R_3 and R_5. A row of eight sturdy setae, their tips crossing, on hind tibia; two long setae on lower anterior edge of hind femur before the apex. Fifth abdominal segment in the female a good deal longer than fourth; sixth tergite slightly longer than half the length of the fifth; seventh (ovipositor) just under two thirds the length of the sixth and several times sl than its own width. Body length 3.5 mm.

Coloration dark. Head light yellow, antennae and frontal band dark yellow. Thorax black and shining, with the usual light (milky-white bands on the sides and a light scutellum. Legs yellow, with dark middle and hind femora. Fore femora brown above, light below. Abdomen black and shining, with narrow, light-gray bands of

pollen on caudal margins of second to fourth tergites and traces of pollen laterally on caudal margin of fifth tergite. The male is not known.

Distribution and material: The description is based on material from Western Europe (Holland); the species is known to the author only from a single female (Switzerland?) in the Zoological Institute of the USSR Academy of Sciences (Kowarz Collection), Leningrad.

Ecology: Not known.

Rhagoletis scutellata Zia, 1938.

Zia et Chen, 1938:34.

Comparison: Near Rh. batava Hering, from which it differs in having a completely black abdomen and very sparse pollen on the thoracic notum.

Short description (after Zia et Chen, 1938, abbreviated): Head yellowish brown, thorax and abdomen blackish. Frons of equal width with eye, narrowing slightly in front, with very delicate hairs in the middle; posterior surface of head yellow and brown, with a pair of large black and brown patches above. Antennae yellow and brown, third segment more or less darkened, slightly more than twice as long as its own width and pointed at the end; arista blackish, except for the base, and weakly but noticeably hairy. Palpi yellow. Thorax black, with grayish pollen; humerus and pleural band pale yellow towards base of wing. dc seta slightly before sa level. Wing markings as in Rh. reducta but with the apical band in a different position, at a distance from the wing margin. Vein r_5 has only one seta at the base. Legs yellow and brown; femora blackish, except for the distal extremities. Abdomen black. Fifth tergite shining, slightly shorter than the third and fourth combined; other tergites more or less covered with an ashy gray pollen. Body length 3.7 mm, wings just under 4 mm. Female not known.

Distribution and material: Description based on material from North China (northeastern Hansu); not known to the author under natural conditions.

Ecology: Not known.

Rhagoletis zernyi Hendel, 1927.

Hendel, 1927:76.

Comparison: Sharply distinct from all other palaearctic species by the bridge joining the second and third wing bands; otherwise nearest to Rh. flavigenualis Her.

Short description (after Hendel, 1927, abbreviated): Male. Frons equal in width to eye and slightly more than half as long again as its own width, with parallel sides. Setae shorter than in Rh. cerasi. Head and its appendages light yellow, partly covered with a silky-white pollen. Thorax black, with a bright sheen; humeri and their bands white-to-yellow near wing bases, as is the greater part of the scutellum. Thoracic notum with four bands of yellowish-white pollen which become shorter posteriorly. Caudal and lateral edges of tergites shiny yellow; posterior half of fifth tergite and posterior third of second to fourth tergites with a mat yellow pollen. Abdomen below almost completely yellow. Genitalia shiny black. Legs completely yellow. Wing markings characteristic, consisting of distinct brown transverse bands, which are darker at the edges; the first band separate, the rest merging with one another in the fore part of the wing. Body length 4 mm, wings 3.5 mm.

Distribution and material: Description based on a single male specimen from Spain; unknown to the author under natural conditions.

Ecology: Not known.

Rhagoletis flavicincta Loew, 1862 (Figs. 4-7).

Loew, 1862; Enderlein, 1934; Hering, 1958:2.

Comparison: A peculiar species, near Rh. almatensis Rohd., sp. n., Rh. reducta Hering and somewhat similar to the North American Rh. berberis Curran, clearly distinguished by having fore and middle femora and a large part of the hind femora light-colored, the presence of light markings on abdomen and the absence of a median short band on the wing.

Short description: Third antennal segment twice as long as second, pointed; very short, sparse hairs on arista. In male, fronst distinctly wider than eye above, same width as eye in female; narrowing considerably in front to about 1/4-1/5 width of head. Three, very rarely four or two ori; vte half as long as vti. Frontal band with very sparse, short, black hairs. Parafacials at their narrowest two or three times as wide as the thickness of the arista. Genae 2/3 to 3/4 as long as third antennal segment in the middle, somewhat bulging behind. Thoracic notum covered with dense light-gray pollen forming

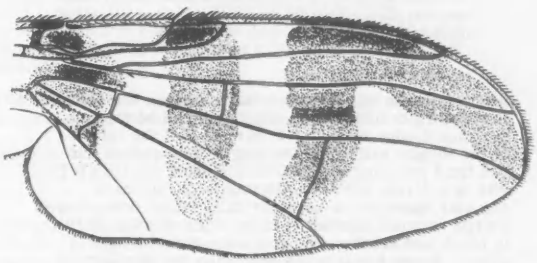

Fig. 4 - Rhagoletis flavicincta Loew, male: wing (Voronezh prov., prep. 1822; drawing by E. Rohdendorf-Golmanova).

four clearly demarcated and fairly broad cross bands. Wing markings as in Rh. reducta. Hind tibia with a row of 7-10 setae on upper front edge, their tips crossing to a considerable extent. In the male the fourth abdominal tergite is a quarter as long again as the third, the fifth a third to a half as long again as the fourth. Male genital appendages like those of Rh. almatensis and Rh. cerasi, except for the broad bases of the coxites, which are noticeably curved back at the extremity. Cerci broad and flabellate. Sixth tergite of female abdomen noticeably shorter than fifth; seventh tergite (ovipositor) shorter than sixth, usually very retracted, a good deal wider than its own length. Body length 2.75-4.0 mm.

Head light yellow; frontal band reddish. Thorax black, scutellum light yellow, slightly darker at the base and sides. Legs light yellow, hind femora slightly darker at the middle, especially in the males. Abdomen mainly yellow, with black and brown markings in the form of bands and patches on the anterior margins of the tergites. In the males the first tergite is completely black, the second has a narrow yellow border, the third a border which takes up a quarter to half its length and sometimes has a median projection

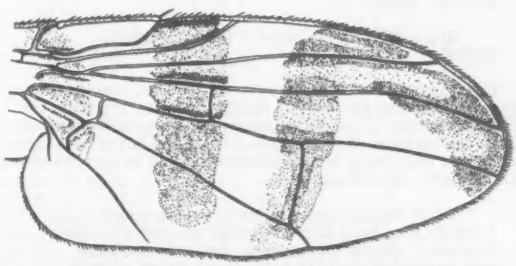

Fig. 5 - Rhagoletis flavicincta Loew, female: wing (Voronezh prov., prep. 1821; drawing by E. Rohdendorf-Golmanova).

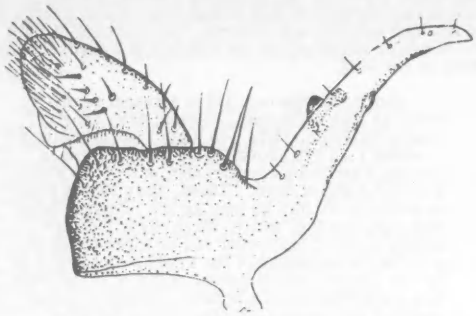

Fig. 6 - Rhagoletis flavicincta Loew, male: anal tergite, cerci and coxites (Voronezh prov., prep. 3202).

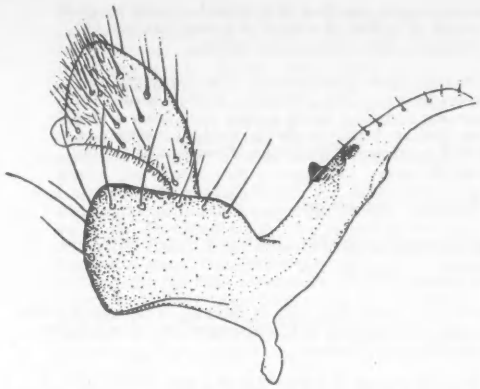

Fig. 7 - Rhagoletis flavicincta Loew, male: anal tergite, cerci and coxites (Alma-Ata area, prep. 3032).

which is in its way a rudimentary median band. The fourth tergite has a wide, light-colored border on the caudal edge taking up a third to half the length of the tergite and a median longitudinal yellow and red band reaching to the anterior edge; the fifth tergite is entirely yellow, with four separate dark circular spots in the anterior half, which sometimes merge with one another. In the male the anal tergite is black and shining, the coxites and cerci light in color. In the females the markings are similar but more variable. The second to fifth tergites have light posterior margins; the sixth has four clearly demarcated dark patches, the middle ones being smaller than the lateral ones. There is usually a median light band, at least on the fourth and fifth tergites and often on the third as well; sometimes the reduction of the dark markings goes further and in extreme forms the third to fifth tergites are yellow, with four or even only two dark spots in the middle; in this case the sixth tergite has only four barely noticeable brown spots. The ovipositor (seventh tergite) is shiny black or brown (such light-colored individuals have been found in the vicinity of Alma-Ata).

Distribution and material: Description based on material from Germany; species known to author from numerous male and female specimens from Voronezh (Kamennaya Steppe), Lugan' (Derzhul'sk forestry, E. F. Kozarzhevskaya, Rh. rossica Rohd., sp. n.) and Stalingrad (Sarepta) provinces, Southeast Kazakhstan (vicinity of Alma-Ata) and Tadzhikistan (Varzob valley, Kondar gorge).

Ecology: Feeds on honesuckles Lonicera tatarica L., (reared from larvae by B. Vereshchagin and E. F. Kozarzhevskaya in Voronezh and Lugan' provinces) and Lonicera stenantha pojarc. (reared from larvae by Ye. N. Samoylovich and M. N. Kandybina in Alma-Ata province).

Rhagoletis flavigenualis Hering, 1958 (Figs. 8-10).

Hering, 1958:3.

Syn.: Rh. zernyi Rohd., 1936:5; Zaytsev, 1947:6.

Comparison: A brightly colored species, nearest Rh. batava Hering and Rh. zernyi Hend. and differing from the former in having bordered bands on the wing, lighter in the middle and dark on the edges, and from the latter by the second and third wing bands not merging but separated by a distinct light-colored space.

Brief description: Third antennal segment 2 1/2 times as long as the second, pointed towards the apex. Arista thickened at the extreme base and covered with short but distinct hairs. Frons above of same width as eye (♂) or narrower (♀), distinctly longer than it is wide and barely (♂) or a good deal (♀) narrower at the level of the second

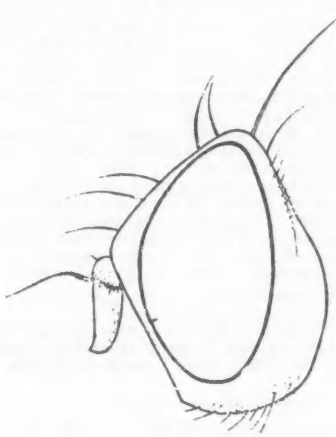

Fig. 8 - Rhagoletis flavigenualis Hering, male: head in profile (Kondara, Tadzhikistan; drawing by M. Kandybina).

antennal segment than at vertex. Three ori; vte a quarter the length of vti. Frontal band with short, sparse, black hairs. Parafacials at their narrowest barely wider than the thickness of the arista, almost linear in profile. Genae moderately broad, about 2/3 the length of the third antennal segment and roughly 1/7 or 1/8 the height of the eyes; slightly bulging behind. Thoracic notum with thick gray pollen forming four longitudinal bands; the spaces be-

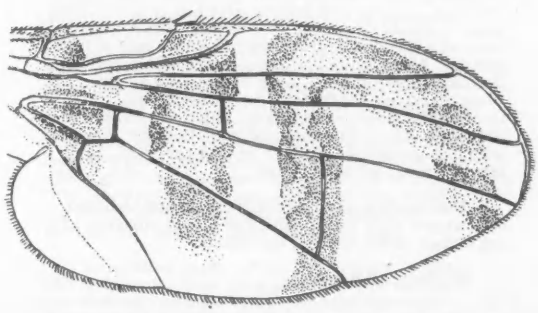

Fig. 9 - Rhagoletis flavigenualis Hering, female: wing (N. Caucasia, Anapa, prep. 2201; drawing by E. Rohdendorf-Golmanova).

tween these wide and of almost equal width. dc setae only just behind the sa level. Wing markings as in Rh. batava Hering; the space between the second and third bands varying in width and more or less the same width as the third band; the colorless area between the wing edge and the fourth band wide, reaching the medial vein posteriorly. Hind tibia with a row (9-12) of strong and long setae, their tips crossing to a considerable extent. Hind femora with 1-2 strong setae on the fore lower edge in front of the apex. In the female the fifth abdominal tergite is 1 1/2 times longer than the fourth; the sixth tergite is 2/3 - 3/4 the length of the fifth; the seventh tergite (ovipositor) is bulging and 1/2 - 3/4 the length of the sixth (depending on the degree of retraction of the abdominal segments) and a good deal wider than it is long at the base. Body length 4.0-4.75 mm.

The head a reddish-yellow, the facial disc and part of the genae light yellow. The posterior surface of the head completely yellow, except for narrow black streaks which reproduce the outline of the endoskeleton (tentorium). Thorax black, with the usual white outline on the scutellum and sides of the notum. The color of the wing bands uneven; each band mainly gray to brown, with a lighter, yellowish part in the middle and a darker hue forming a kind of narrow border. Legs yellow almost throughout, except for dark setae, claws and part of the median and hind coxae. In the male the femora, especially the hind ones, are more or less darkened at the middle. Abdomen black, with yellow bands on the hind margins of the segments, additionally covered with light-colored pollen. The male also with thick pollen on the second to fourth tergites; the fifth tergite shiny, without pollen; the posterior marginal bands varying in width from a third to two thirds the length of the tergites. In the female the second to fifth tergites covered with pollen; the sixth and seventh shining, the former having a reddish border on the posterior margin. Male genitalia shiny and black to brown in color, cerci and coxites light in color.

Genus MICRORRHAGOLETIS Rohdendorf, gen. n.

Generic type: Microrrhagoletis samojlovitshae Rohdendorf, sp. n.

Description: Posterior part of head strongly bulging, its length not less than half that of the eyes; genae moderately broad. Lower edge of head convex posteriorly. Eyes not particularly high; head not short in profile. Ovipositor (seventh tergite) sharply separated from abdomen, equal in length to the two preceding tergites combined and somewhat longer than its own width. Male genitalia fairly large, cerci in the form of long blades, distal part of phallosome elongated, only very slightly enlarged, with membranous blade at the extremity. The body coloration pale yellow with weak brownish markings on the abdomen and thoracic notum. Wing markings of the type, found in Z. alternatum (Fall.) and Rh. cerasi (L.). Body small (2. 5-4. 0 mm).

Comparison: Distinguished by small size and light coloring. Partially similar to genus Rhagoletis in coloration of abdomen and structure of genitalia in the male and to Zonosema in shape of head, light coloration and length of ovipositor.

Distribution and species: Described on the basis of a single species from South Kazakhstan.

Microrrhagoletis samojlovitshae Rohdendorf, sp.n. (Figs. 11, 12, 13).

Description: Male. Third antennal segment twice as long as second, becoming abruptly more slender towards the extremity and sharply angled there. Arista with sparse, short but very noticeable hairs and thickened at the extreme base. The frons above a good deal wider than the eyes, narrowing very slightly towards the anterior extremity. There are three ori and two ors, of which the posterior ones are the more slender.

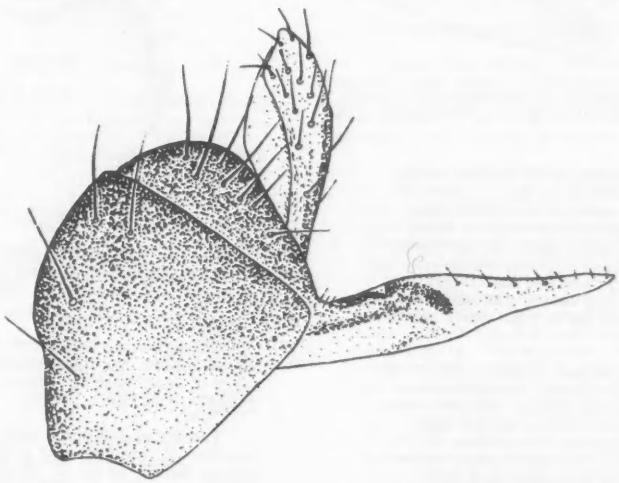

Fig. 10 - Rhagoletis flavigenualis Hering, male: genital and anal tergites, cerci and coxites (Tadzhikistan, prep. 3049).

Distribution and material: Description from material taken in Anatolia; species known to the author from material collected in Krasnodarsk region (kray) (Anapa) and Central Asia (Osh prov., Khaydarkan; Turkestan range, Gurolash; Tadzhikistan, Kondara).

Ecology: The larvae infest the pericarps of juniper and artemisia; species known to the author from material taken from Juniperus excelsa L. (Anapa, V. Gusev) and J. seravschanica Kom. (Khaydarkan, M. N. Kandybina).

vte less than half the length of vti and thinner. Frontal band fairly densely covered with short, light brown hairs. Parafacials not particularly narrow, at their narrowest a third or just under a third the width of the third antennal segment. Genae broad; their height in front of the genal setae about the length of the third antennal segment and a quarter the height of the eye; from behind they bulge even more. Thoracic notum with sparse, barely noticeable whitish pollen, forming indistinct longitudinal bands. dc behind sa level. Wing markings as in M. magniterebra

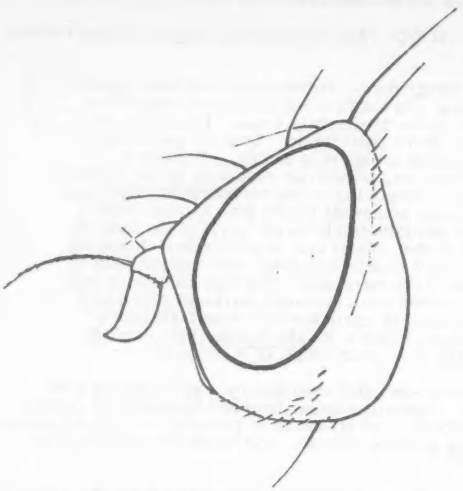

Fig. 11 - Microrrhagoletis samojlovitshae Rohd., gen.n., sp.n., male: head (S. Kazakhstan) (Drawing by M.N. Kandybina).

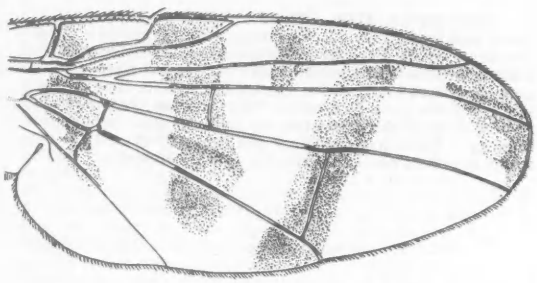

Fig. 12 - Microrrhageoltis samojlovitshae Rohd., gen.n., sp. n., male: wing (S. Kazakhstan; drawing by E. Rohdendorf-Golmanova).

and Rh. cerasi, differing from the former in the wider bands and from both in the paler color. A row of 5-6 short, light setae on hind tibia, their tips just crossing. Hind femora have 1-2 setae on lower anterior edge below apex. No markings on first + second abdominal tergites, which are almost equal in length to third and fourth tergites combined; fifth tergite very large, almost three quarters as long again as the fourth. Body length 2.5-3.0 mm.

Color mainly light yellow. Head, apart from the compound eyes, light-colored throughout except for the extremity of the arista, the ori, ors, oc and vt, which are black and brown; all other setae and hairs light-colored. Coloration of thorax also light except for brown patches on the mesonotum in front of the scutellum and on the postnotal sclerites and brown wing markings. Abdomen also pale yellow; third, fourth and fifth tergites with shining brown bands and patches, with gaps in the middle, on their anterior halves. The narrowest bands, which are often almost vestigial, are on the third tergite and the broadest on the fifth. The anal tergite a more shiny brown; the cerci and coxites light-colored.

The female is distinguished by having more pronounced dark markings. The thoracic notum bears indistinct, circular, mat brown patches in front of the suture (behind the humeri) and indistinct dark longitudinal bands. The abdomen is light yellow, with interrupted brown bands on the fourth and fifth tergites; the sixth tergite is bright yellow except for two small circular brown patches; the seventh (ovipositor) is orange-yellow. Body length 3.75-4.0 mm.

Distribution and material: Description based on 2 ♂♂ and 2 ♀♀ from S. Kazakhstan (Bostandysk district). Reared from larvae obtained from Khumsan locality (Ugam River) in 1937 by Ye. N. Samojlovich: 1 ♀ (No. 3070, 29 June), 1 ♂ (No. 1823, 1 July), 1 ♂ (No. 3076, 2 July and 1 ♀, type (No. 1824, 4 July).

Ecology: The larvae infest the berries of Berberis heteropoda Schrenk. The species is named after Yevgeniya Nikolayevna Samojlovich, who was the first to study these insects in Kazakhstan and collected valuable data on their growth.

Genus ZONOSEMA Loew, 1862

Generic type: Trypeta meigeni Loew, 1844.

Short description: Posterior part of genae abruptly bulging and a good deal longer than half the eye length; height of genae a quarter to a third that of the eye. Lower half of head more or less convex. Ovipositor short but always noticeably longer than sixth tergite. Male genitalia of medium size, with broad flabellate cerci. Apical part of phallosome bulging and elongated. Body light in color, with the thorax and abdomen as a rule mainly yellow (except in the case of Z. chumsanicum Rohd., sp. n.). There is always a short median transverse band among the wing markings, starting at the anterior margin and not reaching back beyond vein r_5.

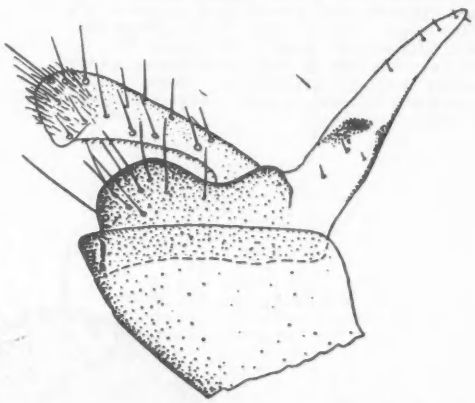

Fig. 13 - Microrrhagoletis samojlovitshae Rohd., gen. n., sp.n., male: anal and genital tergites, cerci and coxites (S. Kazakhstan, prep. 3076).

Comparison: Well characterized by the head which bulges behind, the light coloration and, as a rule, the absence of dark markings on abdomen (except in the case of Z. chumsanicum Rohd., sp. n.).

Taxonomy and distribution: There are five palaearctic species: Z. meigeni (Lw.), Z. alternatum (Fall.), Z. turanicum Rohd., sp.n., Z. kurentsovi Rohd., sp.n., and Z. chumsanicum Rohd., sp.n. The last two are fairly sharply distinct from the others. The genus is apparently to be found in the nearctic region, but the present author cannot be more precise about the North American fauna, owing to lack of data.

Key for Identification of Species

1 (2). Distinct markings on abdomen in the form of dark transverse bands. Thoracic notum and in part the pleural sclerites of the notum brown and black. Larvae infest Berberis berries. South Kazakhstan..... ..... Z. chumsanicum Rohd., sp.n. (page 97).

2 (1). Abdomen without dark bands or other markings. Notum and its pleura light yellow.....3.

3 (4). Third antennal segment blunt at extremity. Postnotum shining black throughout, occasionally with a narrow median opening, in the form of a line. Sharply defined patch on humeral cross-vein. Frons mat, dark orange. Apical wing patch sharply separate with convex inner edge. Larvae infest Berberis berries. Amur province. ..... Z. kurentsovi Rohd., sp.n. (page 97).

4 (3). Third antennal segment acute at extremity; more rarely blunt, in which case the extremity of cell R_1 is light. ..... 5.

5 (6). Cross band on posterior cross-vein continuing straight ahead and emerging on anterior wing margin. Two large black patches on postnotum, taking up the entire length of the sclerite and separated by a light space along the median line. Very distinct and numerous short black hairs on frontal band. Larvae infest rose hips and, possibly, honeysuckle berries. Europe, Kazakhstan..... ..... Z. alternatum (Fallen) (page 98).

6 (5). Transverse band on posterior cross-vein not extending beyond vein r_5 or joining dark apical band in cell R_1 ..... 7.

7 (8). Apical band on wing occupies only the apical end of cell R_1 and is sharply separated from the short median band. Dark circular patch on postnotum with small median opening. Seventh abdominal tergite in female just longer than sixth and darker than the rest of the abdomen. A few, barely noticeable, light hairs on frontal band. Male genitalia light-colored throughout. Larvae infest Berberis berries. Europe..... ..... Z. meigeni (Loew) (page 99).

8 (7). Apical band on wing along costal vein in distal part of cell R_1 reaches nearly to the middle (short) band, with which it sometimes almost merges. Postnotum with two small, clearly separated patches on its anterior edge. Seventh abdominal tergite in female light brown, hardly distinguishable in color from the rest of the abdomen and obviously longer than sixth tergite. A pair of black circular patches on the male genitalia. Single short, black hairs in the middle of the frontal band. Larvae infest rose hips. Eastern Kazakhstan..... ..... Z. turanicum Rohd., sp.n. (page 100).

Zonosema chumsanicum Rohdendorf, sp.n. (Fig. 14).

Comparison: Sharply distinguished from all other species of this genus known to the author; the dark abdominal and thoracic markings are reminiscent of species of the genus Rhagoletis but the broad genae and long ovipositor distinguish this species from them.

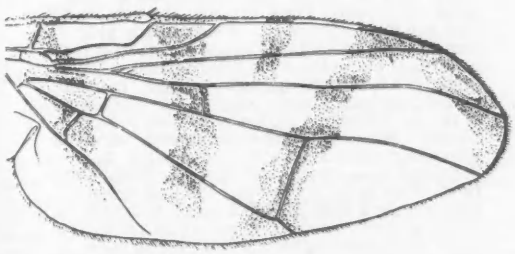

Fig. 14 - Zonosema chumsanicum Rohd., sp.n., female: wing (S. Kazakhstan, type, prep. 1820; drawing by E. Rohdendorf-Golmanova).

Description: Female. Third antennal segment half as long again as second, narrowing abruptly towards the extremity and ending in an acute angle. Arista thickened at the base, with short, not particularly sparse hairs. Frons above visibly wider than eye, narrowing slightly towards the front and somewhat longer than wide; three ori, two ors, the posterior ones being slightly shorter than the others; vte less than half the length of vti; oc sturdy. Frontal band with sparse, short, black hairs. Parafacials very narrow, slightly wider than the thickness of the arista at their narrowest. Genae broad and roughly the same height as the length of the third antennal segment in front of the genal seta and about a quarter the height of the eye; bulging strongly behind. Sparse gray pollen on thoracic notum; bands of pollen not distinct; dc almost on a level with sa. Wing markings as in M. magniterebra and Z. kurentsovi; a band on the posterior cross-vein joining an apical patch in front; all the other bands separate. Hind tibia with three setae before apex on the anterior edge. First + second tergites shorter than the third and fourth together, these being of equal length; fifth tergite visibly longer than fourth, sixth just shorter than fifth; seventh (ovipositor) more than half as long again as sixth, wide basally and abruptly narrowing at the apex; almost triangular above; its width equal to its length. Body length 4.0 mm.

Head completely yellow, light yellow in places; only the eyes, a patch between the ocelli and the large setae dark. Thorax mainly black and brown; all legs, including coxae, humeri, propleura, the greater part of the mesopleura and pteropleura, "baret", anterior and posterior stigmata and the entire scutellum light yellow. Abdomen light yellow with brownish shiny markings in the form of cross bands and patches. First + second tergite almost entirely dark; its posterior edge with a wide yellow border; third, fourth and fifth tergites each with brown band taking up half to two thirds of the tergite; four oval brown patches on anterior edge of sixth tergite, the median ones being only just over half the size of the lateral ones; ovipositor completely dark brown and shining.

Distribution and material: Description based on one ♀ from South Kazakhstan (Khumsan, Bostandaksk district, Ugam River), 1 June 1937; laboratory-reared from larvae by Ye. N. Samojlovich (coll. No. 1820).

Ecology: Larvae infest Berberis berries (Berberis heteropoda Schrenk).

Zonosema kurentsovi Rohdendorf, sp.n. (Figs. 15-17).

Comparison: Readily distinguished from all other species of the genus by the absence or poor development, of a pointed protuberance on third antennal segment and the blunt coxites of the male genitalia. In the wing markings and color, this species is closest to Z. alternatum (Fall.).

Description: Third antennal segment 1 1/4-1 1/2 times as long as second, slightly narrowed and rounded towards the tip; sometimes a small, short, sharp tooth on the upper anterior angle of the antenna. Arista abruptly thickened at the base and covered with very short but not sparse hairs. Frons above visibly wider than eye, not narrowing towards the anterior end and almost square; 3-4 ori; 2, rarely 3 ors; vte half the length of vti. Frontal band almost bare, with very sparse short hairs. Parafacials narrow, slightly less than half the width of the third antennal segment. Genae very broad, their height at the level of the genal setae greater than the length of the antenna and roughly equal to half the length of the eye. Posterior surface of the head bulging strongly and slightly narrower than the length of the eye; head short in profile. Thoracic notum evenly covered with golden pollen; longitudinal bands indistinct; dc considerably behind sa level. Wing markings resembling those of Z. alternatum but differing in having a dark patch on the humeral cross-vein which also embraces part of the SC and R stem; a transverse band covering the dorsal cross-vein and emerging at the anterior edge, occupying the whole end of the cell R_1; the apical dark patch not extending beyond the end of the vein r_5, leaving a sizeable colorless space along the fifth branch of the costal vein (two-thirds or just under in the female, almost half in the male). A row of 8-10 fairly delicate setae on hind tibia; these setae sturdier in the female and their tips cross. Two uneven setae on anterior lower edge of hind femur before apex. First + second abdominal tergites slightly shorter in the male; equal in length to the third and fourth together in

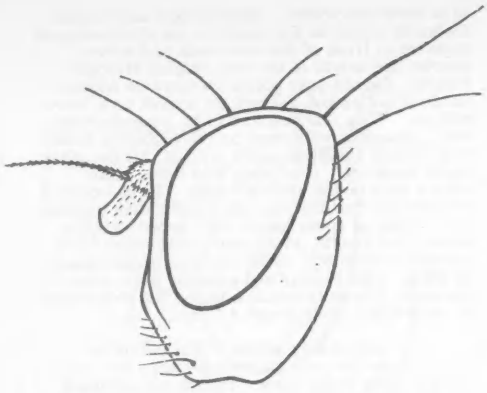

Fig. 15 - Zonosema kurentsovi Rohd., sp.n., male: head in profile (Amur prov.; drawing by M. Kandybina).

the female (these being of equal length). Fifth abdominal tergite half as long again as the fourth in the male, only slightly longer than the fourth in the female. Sixth abdominal tergite half the length of the fifth in the female; seventh (ovipositor) half as long again as the sixth and of roughly the same length as width when viewed from above. Male cerci broad, coxites abruptly blunted at the end and sharply differentiated from those of other species in the group. Body length 4.0-4.75 mm.

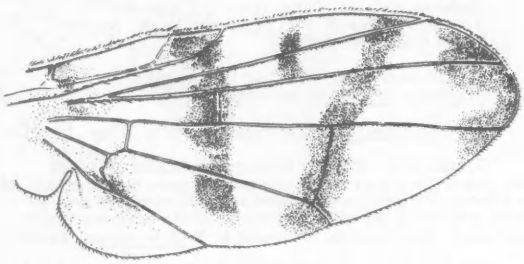

Fig. 16 - Zonosema kurentsovi Rohd., sp.n., male: wing (Amur prov.; drawing by M. Kandybina).

Head yellow; frontal band and usually the genae darker, orange, except for the large setae and the thin part of arista, which are dark brown. Thorax yellow except for the black, shining postnotum. Sometimes a very narrow, light lumen on the postnotum in the form of a longitudinal streak, or barely distinguishable lateral lumina. Almost the entire thorax shiny and only the notum covered with a not particularly thick but very pronounced golden pollen and dense, short, yellow hairs, easily visible under lateral illumination. The legs, apart from the claws and certain large setae, yellow. The abdomen entirely a shining orange-yellow. The ends of the cerci, part of the fifth sternite in the male and the seventh tergite in the female brown and yellow.

Description and material: Description based on 6 ♂♂ and 3 ♀♀ reared from larvae collected on 28 August 1957 in the Amur province (Khingan-Arkharin district, Nikitin: ♂♂, coll. No. 3042, type, No. 3041, No. 3030, unnumbered; ♀♀ - No. 3043 and unnumbered).

Ecology: Larvae infest berries of Berberis Ruprechtii Kom. The species is named after A. I. Kurentsov, who was the greatest expert on Far Eastern fauna and the author of the most comprehensive and reliable zoogeographical research on the insects of these countries.

Zonosema alternatum (Fallen, 1820) (Fig. 18).

Rhagoletis alternata Hendel, 1927:74; Hering, 1958:1.

Syn.: Trypeta continua Meigen, 1826.

Comparison: Nearest Z. kurentsovi, from which it is clearly distinguished by the narrower frons and shorter genae, different wing markings, pointed coxites of the male genitalia and different food plants.

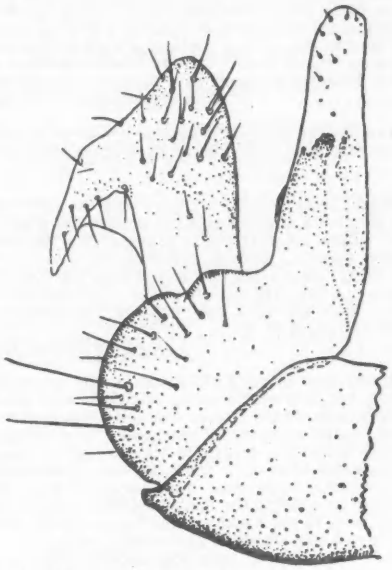

Fig. 17 - Zonosema kurentsovi Rohd., sp.n., male: genital and anal tergites, cerci and coxites (Amur prov., prep. 3030).

Short description: Third antennal segment varies in shape and is roughly twice as long as second. Arista thickened at extreme base and covered with short hairs. Frons noticeably narrower than the eye on top, roughly half as long again as its width; three ori, two ors, vte longer than half the length of vti. Frontal band with numerous short hairs. Female parafacials just under half the width of the third antenna segment, slightly narrower in the male. Genae, in front of the genal seta slightly shorter than the length of the third antennal segment, bulging abruptly behind. Thoracic notum slightly shiny, covered with clear pollen and short golden hairs; dc somewhat behind sa level. Wing markings similar to those of Z. kurentsovi; humeral crossvein without a dark patch but with a yellowish marking; cross bands on cross-veins rm and tp come very close together behind; the tp band emerges at anterior edge, leaving the end of cell R_1 light-colored; the apical patch different in each sex, being larger in the female and approaching very close to the end of vein r_3. Leg setae vary. First + second abdominal tergites in male appreciably shorter than the third and fourth tergites combined; fifth a quarter as long again as the fourth. In the female the first and second tergites together are equal in length to the third and fourth combined; the fifth is the longest, being roughly a quarter to half again the length of the fourth; the sixth is short, just under two thirds the length of the fifth; the seventh tergite (ovipositor) is a half to three quarters as long again as the sixth, above; its width (on being pressed upwards from below when the insect is dried out) is greater than its length. The male cerci are protruding and not particularly wide;

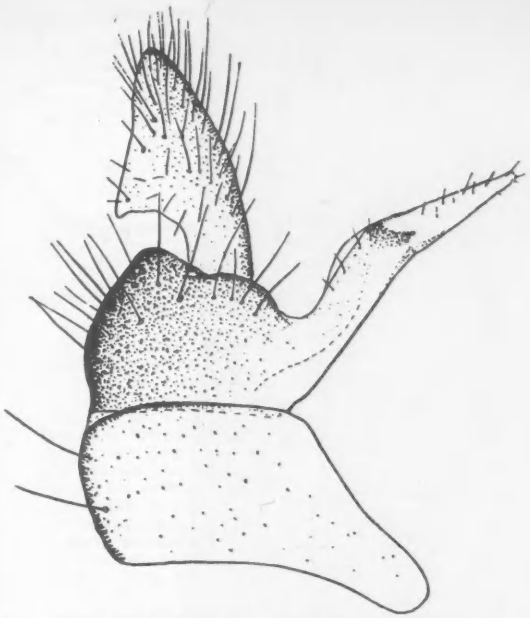

Fig. 18 - Zonosema alternatum alternatum (Fallen), male: genital and anal tergites, cerci and coxites (Alma-Ata area, prep. 3029).

the coxites sharp and narrow. Body length 5-6 mm.

The head, except for a few setae, is light yellow, the frons orange-yellow. Thorax and legs are orange-yellow; there are two shiny black patches on the postnotum, separated by a wide light-colored space which broadens out towards the back. The abdomen is shiny and colored orange-yellow or pale yellow. The ovipositor is brown and yellow along the edge or throughout. In the male the anal tergite is shiny and brown, the cerci dark-colored.

This very widespread species shows pronounced geographical variability, so that one must distinguish two varieties, which are probably subspecies:

1 (2). Third antennal segment narrowing abruptly towards the apex and ending in a sharp protuberance; frontal band thickly covered with short black hairs, which occur on the anterior part of the band as well. Europe, Kazakhstan .....Z. alternatum alternatum (Fallen).

2 (1). Third antennal segment blunt, with a very short angular protuberance at apex above. Sparse hairs on posterior half of frontal band. Far East..... ..... Z. alternatum orientale Rohd., ssp. n.

Z. alternatum alternatum (Fall.). Typical subspecies, apart from the characters indicated in the above key, characterized by a brighter, reddish-orange body hue. Known to the author from material from Western Europe (Hammern, Mika Coll. in USSR Academy of Sciences, Institute of Zoology), from the Ryazan province (Gremyachka, A. Semenov - Tyan'-Shan') and Eastern Kazakhstan (Alma-Ata area). The Kazakhstan material was obtained from larvae infesting the fruits of Rosa spinosissima.

Z. alternatum orientale Rohd., ssp. n. This eastern variety is readily distinguished by the further peculiarity of a good deal lighter, pale yellow body hue. Material known to the author is from the Amur and Sakhalin provinces and the Khabarovsk region: Khekhtsirsk forestry, Khabarovsk region, 1 ♀, type, from larva collected on 18 August 1958 (Nakonechnyy); area between rivers M. Pera and B. Ergil', Amur province, 2 ♀♀, larvae collected on 9 September 1958 (Nakonechnyy); Khabarovsk, 3 ♂♂ obtained from larvae in March 1959 (G. G. Shil'd and Nakonechnyy), 1 ♂ on 5 July 1916 (Pavlenko); Dolinsk, Sakhalin province, 3 ♀♀ from larvae collected in September 1954 (V. N. Lyubarskaya). Food plant: Rosa acicularis.

Zonosema meigeni (Loew, 1844).

Rhagoletis meigeni Hendel, 1927:74.

Comparison: Clearly distinguishable from other species by the shortened transverse band on the wing, situated on the tp and not reaching the anterior edge, and by the distinct (not merged) apical patch and median band of the wing, the presence of one median patch on the postnotum and the blunt coxites of the male genitalia. Nearest the species Z. turanicum Rohd. sp.n. and Z. kurentsovi Rohd., sp. n.

Short description: Third antennal segment 1 1/2-1 3/4 times as long as second, thinning evenly towards the tip and pointed at the end. Arista thickened basally and covered with short hairs. Frons above roughly the same width as eye, narrowing slightly in front and somewhat longer than its width; three ori; two, rarely three ors; vte half as long as vti. Frontal band covered with scattered short hairs. Parafacials at their narrowest roughly one third the width of the third antennal segment. Genae vary considerably in width, being three quarters to one and a half times the length of the third antennal segment or a fifth to two fifths the eye height; in the male the genae are particularly broad. Posterior surface of head correspondingly strongly bulging. Thoracic notum very slightly shiny, with thick golden-yellow pollen and short golden hairs; longitudinal bands of pollen not distinct. dc situated only just behind sa level. Wing markings peculiar and characterized by a shortened transverse band which does not attain the anterior edge and is situated on cross-vein tp. Humeral cross-vein with no dark patch but only a light yellow marking lying distally. Apical patch large but separated sharply from median band by a broad colorless space opposite the extremity of the tp band. A variable number of setae (4-8) on the hind tibia (particularly weak and few in number in the male); hind femora with 2-4 slender but long setae on anterior lower edge before apex. Abdomen almost entirely covered with light hairs. First + second tergite on male abdomen a good deal longer than third and fourth combined; fourth just longer than third; fifth half as long again as fourth. In the female the first + second tergites are the same length or slightly longer than the third and fourth combined, the latter being of roughly equal length; fifth tergite a quarter as long again as fourth; sixth just under two thirds the length of the fifth; seventh (ovipositor) a quarter as long again as the sixth above, its width greater than its length. Body length 4.5-5.5 mm.

Head light-yellow throughout; frontal band, antennae and genae orange-yellow in front. Thorax completely yellow except for a large, round, shiny-black patch in the center of the postnotum; this patch sometimes has a barely perceptible circular lumen in the middle. Four lighter (less transparent than the rest of the surface) longitudinal bands on thoracic notum, usually barely perceptible owing to the thick light-colored pollen. Legs light yellow; in the male the terminal segment of all tarsi, and sometimes also the four last segments of the fore and median tarsi, are brown. Wing markings uniformly brown. Abdomen completely mat yellow, without markings. Male genitalia light, ovipositor completely brown and shining, sharply contrasting in color with the rest of the abdomen.

Distribution and material: Europe. Known to the author from the Leningrad, Yaroslavl and Kiev provinces of the USSR and also from West European material from Germany in the old collections of the Institute of Zoology. The great amount of variation in the shape of the head and certain other structural peculiarities make it difficult to believe that all the insects examined really belong to a single species. In the author's opinion, cognate species or subspecies will inevitably have to be distinguished once fuller collections are available and studied.

Ecology: Larvae infest the berries of Berberis vulgaris L.

Zonosema turanicum Rohd., sp.n. (Figs. 19, 20).

Comparison: Readily distinguishable from all other species in the group by the wing markings: the apical patch extends along the ventral margin up to the median short cross-band, almost merging with it, while the tp band is shorter, as in Z. meigeni (Lw.), and does not reach the wing edge. Nearest to Z. alternatum Lw., from which it is well distinguished by the wing markings.

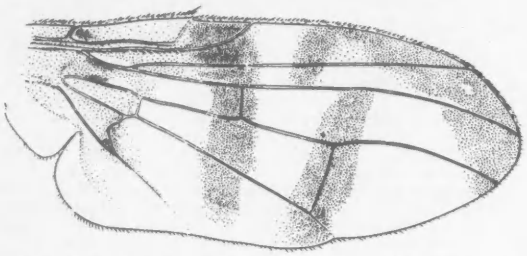

Fig. 19 - Zonosema turanicum Rohd., sp.n., male: wing (Alma-Ata area; drawing by M. Kandybina).

Description: Third antennal segment twice as long as second, gradually narrowing towards the apex, where it ends in a very large, sharp spine, larger than in any other species of the group. Arista thickened basally and covered with very short hairs. Frons above distinctly wider than eye, hardly narrowing at all towards the anterior end and roughly square; 2-3 ori, 2 ors, vte half the length of vti. Frontal band with very sparse, short, black hairs and in the male practically bare. Parafacials at their narrowest half as wide as the third antennal segment (slightly narrower in the male). Genae broad; their height in front of the genal seta equal to the length of the third antennal segment (sometimes slightly more) or about a quarter the eye height; wider in the male. Head bulging strongly behind. Thoracic notum covered with thick whitish pollen, forming an indistinct pattern in the form of two dark longitudinal streaks. dc behind level of sa. Wing markings peculiar (see above); apical patch of vague outline. Distally of humeral cross-vein there is a dark patch, joined to the basal SC, R, M and CuA stems by darkened areas, forming a rudimentary basal transverse band. The bands on rm and tp come very close together on the posterior margin. A row of 8-11 setae on hind tibia, sturdier in the female. Hind femora with one, more rarely two, setae on anterior lower edge before the apex. The abdomen covered with not particularly short, black hairs, mixed with which light hairs on the anterior tergites. First + second abdominal tergites of the male equal in length to the third and fourth combined, these being of equal length; fifth tergite half as long again as fourth. These proportions are roughly the same in the female, in which the sixth tergite is half as long again as the fifth, and the seventh (ovipositor) varies in length (it may be half as long again as the sixth, or shorter than it when the abdomen is deformed by drying). The ovipositor is, as usual, much shorter above than below, closely covered with black hairs and has a posterior margin of complicated structure. The body length is 5.0 to 5.5 mm.

The head is whitish-yellow, the frontal band, antennae and sometimes the vibrissal angles orange-yellow. Thorax and legs are whitish-yellow throughout; the postnotum has two black, distinctly separated triangular patches on the ventral edge and sometimes, in addition, two small, black, circular spots on the posterior margin. The abdomen is shiny yellow, with vague markings (owing to the translucence of the internal organs). The abdominal pollen is better developed on the female. The anal tergite in the male has two sharp, black spots. In the female, the seventh tergite (ovipositor) is dark orange, shining and, like the greater part of the abdomen, covered with black hairs.

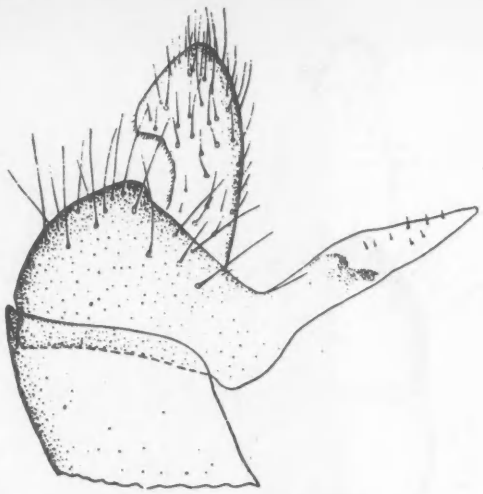

Fig. 20 - Zonosema turanicum Rohd., sp.n., male: genital and anal tergites, cerci and coxites (Alma-Ata area, prep. 3026).

Distribution and material: Description based on flies reared from larvae from East Kazakhstan (Alma-Ata area, 14 August 1957, M. N. Kandybina: 1♂ No. 3038, type; 1 ♂ No. 3036; 1 ♀ No. 3039) and S. Kirgizia (Osh prov., 29 July 1959, Nakonechnyy).

Ecology: Larvae infest fruits of Rosa spinosissima L.

Genus MEGARRHAGOLETIS Rohdendorf, gen. n.

Generic type — M. magniterebra Rohd., sp. n.

Description: Posterior part of head bulges greatly in lower half and is a good deal longer

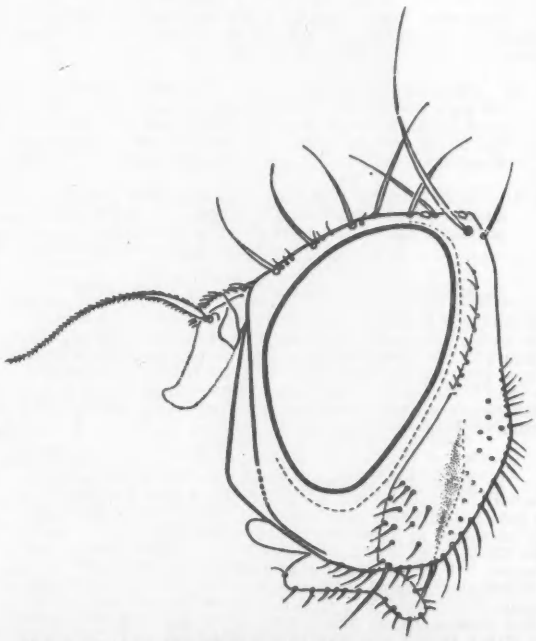

Fig. 21 - Megarrhagoletis magniterebra Rohd., gen.n., sp. n., female: head in profile (Alma-Ata area; drawing by E. Rohdendorf-Golmanova).

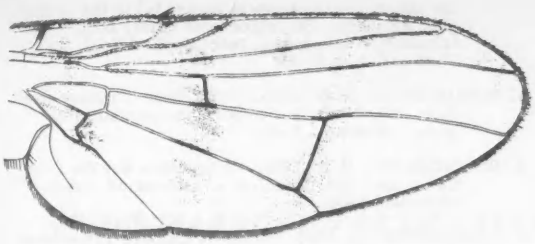

Fig. 22 - Megarrhagoletis magniterebra Rohd., gen.n., sp.n., male: wing (Alma-Ata area, type, prep. 1818; drawing by E. Rohdendorf-Golmanova).

than half the eye length (not less than two thirds); genal height about or just under a quarter of eye height. Lower margin of head very convex; dc appreciably in front of sa level. Ovipositor very large, longer than the rest of the abdomen, irregularly cylindrical. Male genitalia also very large, with long, protruding, rod-shaped cerci and sharply curved coxites, the apices reaching almost the middle of the ventral abdominal surface. Apical part of phallosome small, elongated and slightly bulging. Body brightly colored, with contrasting markings in the form of yellow bands on the abdomen and patches of pale pollen on the thorax. Wing markings include a short median transverse band on apical patch which merges with the band on cross-vein tp. The insects are relatively large (5-7 mm).

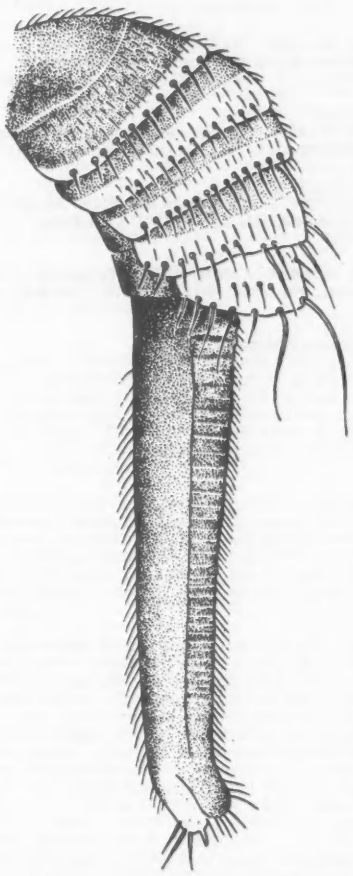

Fig. 23 - Megarrhagoletis magniterebra Rohd., gen.n., sp.n., female: abdomen in profile (Alma-Ata area; drawing by E. Rohdendorf-Golmanova).

Comparison: Sharply distinct from all other genera in the group by its long ovipositor and the large genitalia of the male. The head structure allies this genus with Zonosema Loew; the dark coloration of the thorax and the thick pollen on it are reminiscent of certain species of the genus Rhagoletis Lw. (for example, Rh. flavigenualis Hering).

Taxonomy and distribution: The sole species known is from Central Asia (Transilian Ala-Tau, Ugam and Turkestan ranges).

Megarrhagoletis magniterebra Rohd., sp.n. (Figs. 21-24).

Description: Third antennal segment twice to two and a half times the length of the second, fairly slender, with appreciably concave superior and convex inferior margins, ending in an acute angle. Arista thickened at extreme base, with very short, not dense, hairs. Frons above considerably wider than eye, narrowing appreciably towards anteriorly. Usually three ori, more rarely two or four; two ors, the posterior ones shorter; vte more than half as long as vti. Frontal band: In the male the frontal band is almost completely bare; in the female there are sparse, short, slender hairs in the middle part. Parafacials broad, roughly two thirds the width of third antennal segment. Genae broad; their height in front of the genal seta roughly equal to the third antennal segment or a quarter the eye length. Thoracic notum covered with very thick whitish pollen, forming a pattern of two narrow, dark, longitudinal streaks in front of the suture. Wing markings as in M. samojlovitshae and Rh. cerasi except that the bands are narrower. Eight to twelve slender, rather sparsely arranged setae, their tips just crossing, on hind tibia. Two or three setae (more rarely, one seta) on hind femora, on lower anterior edge before apex. First + second tergites in both sexes perceptibly longer than the third and fourth together; third and fourth of equal length in male; fourth slightly longer in female; fifth tergite in male very large, a good deal longer than the middle tergites combined; fifth, in female, only half as long again as fourth; sixth, in female, shorter than fifth and equal to fourth; seventh (ovipositor) very large, slightly compressed laterally and somewhat flattened above and as long as the rest of the abdomen. The whole abdomen is covered with light or black hairs on the

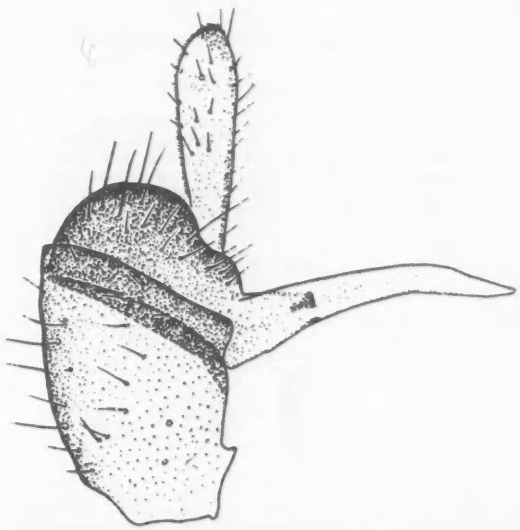

Fig. 24 - Megarraholetis magniterebra Rohd., gen.n., sp. n., male: genital and anal tergites, cerci and coxites (Alma-Ata area, prep. 3073).

correspondingly colored parts. Body length 5.0-7.0 mm.

Head light yellow; antennae and frontal band somewhat darker. Thorax mainly black; the humeri, upper part of the mesopleura, stigmata, "baret" and scutellum white; the mesopleura below, the notpleura, propleura and sometimes part of the pteropleura reddish; the postnotum completely black and very shiny. Legs completely orange-yellow in both sexes. Wing bands evenly colored. Abdomen has light pollen and contrasting pattern in the form of yellow bands on the posterior margins of the segments. There is a narrow border of the first +second tergite, even in the female, wider and uneven in the male; third and fourth tergites have yellow borders which take up two fifths or half in the female, and half to three quarters in the male, of the length of the tergite along the median line; fifth tergite in male shiny, contrasting, free from pollen and orange-yellow in posterior half; in the female it is the same color as the fourth; sixth tergite in female usually entirely yellow although sometimes there are four narrow black spots on the extreme anterior edge. Ovipositor black and shining. Male genitalia shining; anal tergite black, genital tergite brown, cerci yellow. Abdominal sternites yellow with black markings.

Distribution and material: Description based on 12 ♂♂ and 11 ♀♀ from Central Asia: Alma-Ata prov., near Alma-Ata (Glubokaya Shchel', 28 May, 1 ♂, 1 ♀; Zapovednik; 11 July, 1 ♂; 13 July, 4 ♂♂ (No. 1818, type), 2 ♀♀; 17 July, 3 ♀♀, all reared from larvae by Ye. N. Samojlovich in 1937; Kamenskoye ushchel'ye: 22 June 1938, 2 ♂♂, 3 ♀♀, A. G. Kandybina); South Kazakhstan prov., Ugam River basin (Khumsan, 29 May 1937, 1 ♂, from larva, Ye. N. Samojlovich) and Turkestan range (Gurolash, 60 km from Zaamin, 30 June 1947, N. I. Fursov).

Ecology: Larvae infest berries of Berberis heteropoda Schrenk.

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ON THE DIAGNOSTICS OF THE LARVAE OF FRUIT-FLIES (DIPTERA, TRYPETIDAE)

M. N. KANDYBINA

The family Trypetidae contains a large group of species which develop in the fruits of trees and shrubs. A good many of them — the Mediterranean fruit-fly, the American apple fly, the cherry fly and others — do a great deal of damage to fruit crops every year; yet they have been insufficiently studied, especially in the larval stage, which has remained unknown ground to this day in regard to many species.

Fig. 1 - Structure of fruit-fly larva, lateral view (after Efflatoun, 1927). a - stomatopharyngeal apparatus; b - anterior spiracle; c - posterior spiracle.

In this paper we describe the full-grown larvae of six species of fruit-flies belonging to the genus Rhagoletis and related genera, on the basis of material collected by the author in the vicinity of Alma-Ata and in the province of Leningrad. Two of the species collected and reared at Alma-Ata (Zonosema turanicum and Megarrhagoletis magniterebra) are new, according to Rohdendorf's definition, and are described by him in another paper (1961). The terminology used by Rohdendorf (1938) and Zimin (1948) is used in this paper.

The work was done at the Faculty of General Entomology, Leningrad, (Institute of Applied Zoology and Phytopathology, USSR Ministry of Agriculture).

The larvae of fruit-flies, as indeed of all cyclorrhaphous Diptera, are characterized by the absence of legs or chitinized head capsule and by a reduced number of spiracles, usually represented by one pair of thoracic and one pair of abdominal stigmata. The body is vermiform and anteriorly constricted. It consists of a head segment, three thoracic and eight abdominal segments (Fig. 1).

The head segment bears a pair of short antennae and a pair of maxillary palpae. The mouth opening is in the lower part of the head segment and has mouth hooks, or mandibular sclerites, projecting from it. Preoral teeth may develop anteriorly or laterally of the mouth opening (Fig. 2); so too may preoral flabella — small lobes which are transversely furrowed (Fig. 3).

The stomatopharyngeal apparatus (Fig. 4) is made up of a system of paired sclerites. The anterior sclerites partially protrude from the mouth opening and are known as the mandibular or mouth hooks. The central part of the stomatopharyngeal apparatus is represented by hypostomal sclerites, under which smallish subhypostomal sclerites may develop (Fig. 20, a). The largest sclerites in the stomatopharyngeal apparatus are the pharyngeal sclerites; these are articulated to the bases of the hypostomal sclerites. Their posterior extremities are extended in the form of wings and subdivided into dorsal and ventral processes. Above the hypostomal sclerites are smallish, thin parastomal sclerites, which are the anterior extensions of the pharyngeal sclerites.

A pair of flabelliform anterior spiracles is situated on the first thoracic segment at its boundary with the second. They consist of a spiracular vestibule or atrium and of flabella, or protuberances spreading fanwise distally, which ter-

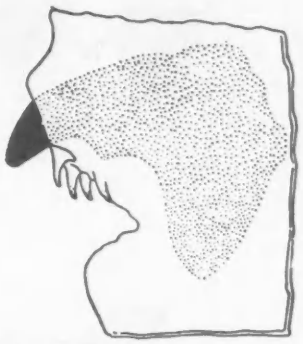


Fig. 2 - Arrangement of preoral teeth and mandibular sclerites in Rhagoletis cerasi L. (after Samoggia, 1932).

minate with an opening, the spiracular slit (Fig. 5).

The abdominal segments often have transverse folds and spine zones on their surface. The eighth segment bears a pair of posterior spiracles dorsally (Fig. 8). These are formed of stigmal plates, in which there are usually three spiracular slits. In most fruit-flies the interspiracular processes surrounding the slits (Fig. 9) are well developed. On the ventral side of the eighth segment is the anal orifice. The hind segment of the body very often bears paired protuberances or tubercles.

Description of Full-Grown Fruit-Fly Larvae

1. The cherry fly (Rhagoletis cerasi L.) (Figs. 4-11).

The larvae are narrow towards the head extremity and dirty white in color. Preoral teeth large, well developed, four on each side. Preoral furrows not developed. Mandibular sclerites crescent-shaped, with a very pronounced tooth on the concave surface, and basally often

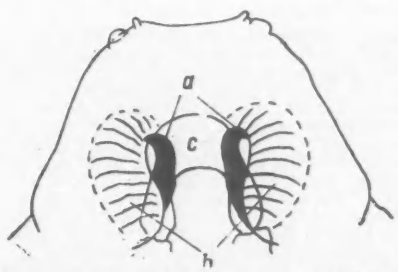
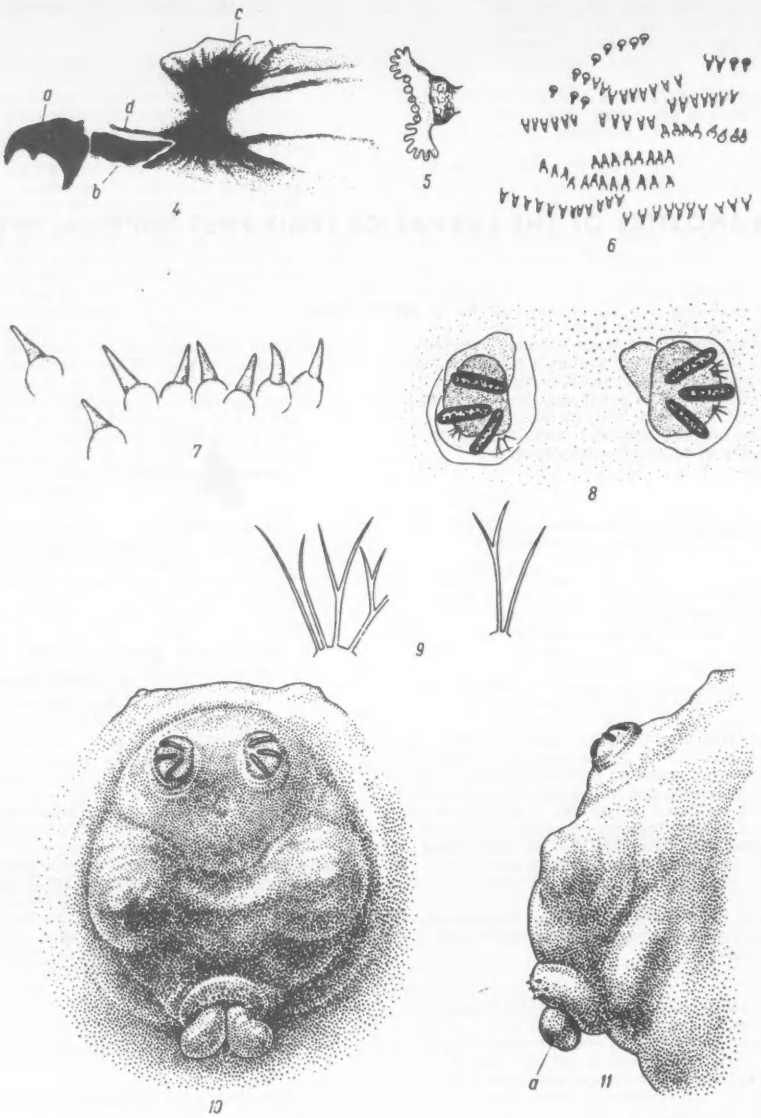


Fig. 3 - Structure of head segment of fruit-fly larva, ventral view (after Efflatoun, 1927). a - mandibular sclerites; b - mouth flabella; c - mouth opening.

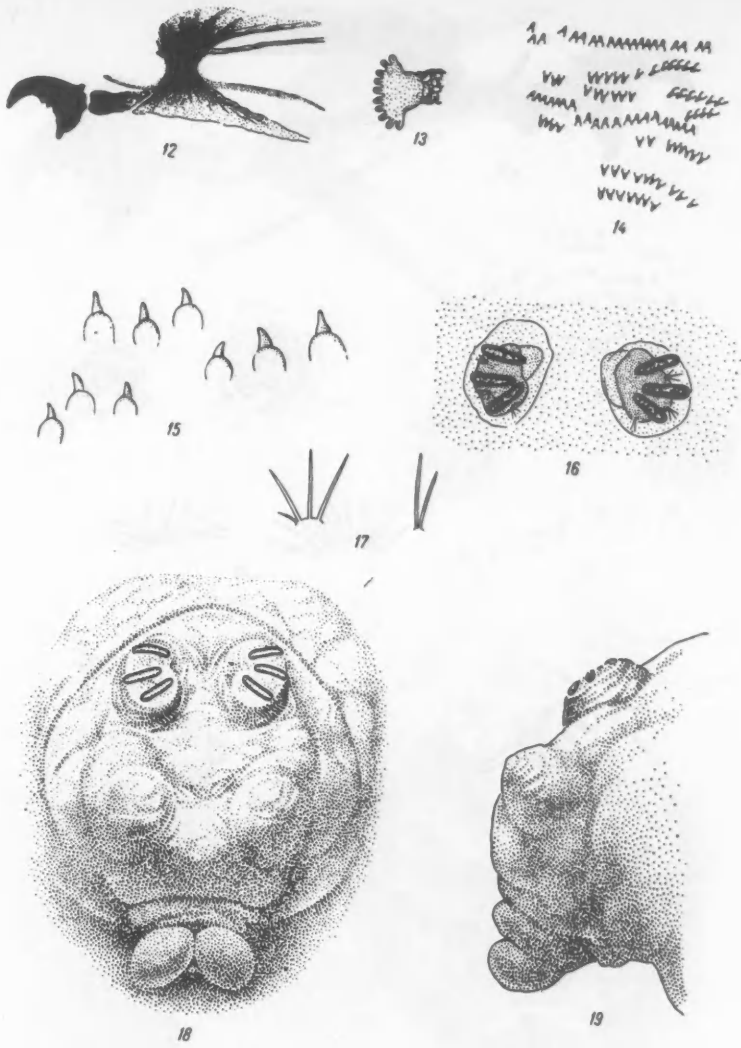


Figs. 4 - 11. Cherry fly (Rhagoletis cerasi L.) (orig.). 4 - stomatopharyngeal apparatus (a - mandibular sclerite; b - hypostomal sclerite; c - pharyngeal sclerite; d - parastomal sclerite); 5 - anterior spiracle; 6 - arrangement of spines on abdominal segments; 7 - structure of spines; 8 - posterior spiracles; 9 - interspiracular processes; 10 - structure of posterior extremity of larva, rear view; 11 - structure of posterior extremity of larva, lateral view (a - anal lobes).

massive. Hypostomal sclerites gradually narrowing posteriorly, their length being three times their width. Parastomal sclerites narrow, extending anteriorly slightly beyond the middle of the hypostomal sclerites. Dorsal and ventral processes of the pharyngeal sclerites subdivided into narrow interior and broad exterior plates; their length slightly exceeding the width of the basal part of the sclerite. Anterior spiracles with 16 short, circular tubules. Narrow transverse folds on the thoracic segments and the first abdominal segment ventrally; broad folds on second to eighth abdominal segments, with numerous spines forming discontinuous irregular rows. The spines sharp, long and basally wide, two to three times longer than their width. Distance between posterior spiracles roughly equal to the diameter of the stigmal plate. Length of spiracular slits of posterior stigmata three to four times their width. The superior slits of the posterior spiracles lie at a slight but perceptible angle to each other, their interior extremities directed downward. Interspiracular processes few, but long, slender and sometimes giving off branches; they occur in small groups of two to five. Below the posterior spiracles, and slightly wider than they are, is a pair of large tubercles. Anal lobes large, oblong and bent downward. Length of full-grown larva 5-6 mm.

The larvae infest the pulp of honeysuckle berries and of sweet and sour cherries.

Described from material collected from honeysuckle berries in Leningrad and vicinity.



Figs. 12 - 19. Rhagoletis flavicincta (Loew) Enderlein (orig.). 12 - stomatopharyngeal apparatus; 13 - anterior spiracle; 14 - distribution of spines on abdominal segments; 15 - structure of spines; 16 - posterior spiracles; 17 - interspiracular processes; 18 - structure of posterior extremity of larva, rear view; 19 - the same, lateral view.

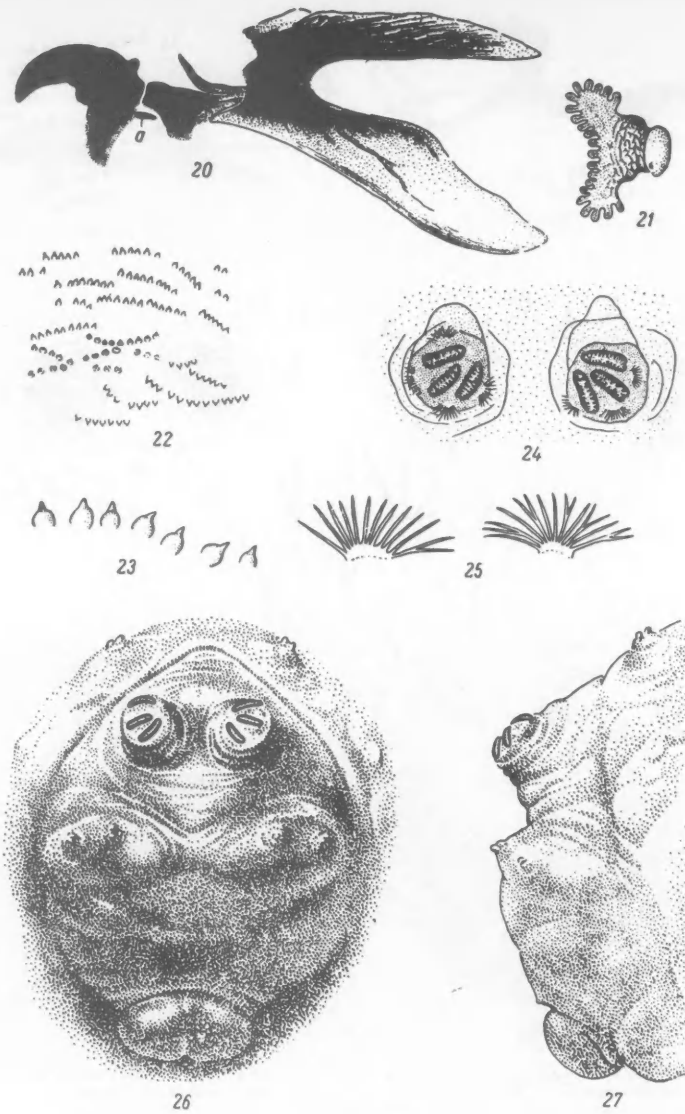
2. Rhagoletis flavicincta (Loew) Enderlein (Figs. 12-19).

Larvae dirty white; structurally similar to Rh. cerasi L. larvae. Preoral teeth large; oral furrows barely perceptible; mouth hooks crescent-shaped, with two small teeth on inner concave surface. Anterior spiracles with ten tubules. Narrow transverse folds on thoracic segments, not clearly marked; wide folds on abdominal segments, with numerous rows of sharp, basally wide spines. Slit in posterior spiracle three to four times as long as it is wide. Interspiracular processes well developed, long, sharp, in groups of two to four. There is a pair of tubercles on the eighth abdominal segment, below the spiracles and slightly broader than them. Anal lobes large and bent downward. Length of full-grown larva 4-5 mm.

The larvae develop in the pulp of Lonicera tatarica L. berries. Material collected in vicinity of Alma-Ata.

3. Zonosema alternatum (Flln.) (Figs. 20-27).

Larvae dirty white or yellowish. Preoral teeth lacking; preoral furrows very distinct. Stomatopharyngeal apparatus massive; mandibular sclerites large, crescent-shaped, with broad bases. Processes of pharyngeal sclerites wide and more than twice as long as the diameter of the sclerite itself. Anterior spiracles with 21-25 short tubules and an enlarged atrium. Body segments separated from one another by well-marked annular furrows consisting of numerous small foveae. Anterior margins of the thoracic segments covered dorsally with numerous small spines gathered into short, irregular rows of eight to ten in a group. On the abdominal segments the spinelets arranged in discontinuous irregular rows not only on the ventral transverse folds but also in a fairly narrow ring over the entire segment. Posterior spiracles slightly convergent, the distance between them being somewhat less than the diameter of the stigmal plate. The spiracular slit two and a half to three times as long as it is wide. Interspiracular processes long, sometimes branching,



Figs. 20 - 27. Wild rose fly (Zonosema alternatum (Flln) (orig.). 20 - stomatopharyngeal apparatus (a - subhypostomal sclerite); 21 - anterior spiracle; 22 - distribution of spines on abdominal segments; 23 - structure of spines; 24 - posterior spiracles; 25 - interspiracular processes; 26 - structure of posterior extremity of larva, rear view; 27 - the same, lateral view.

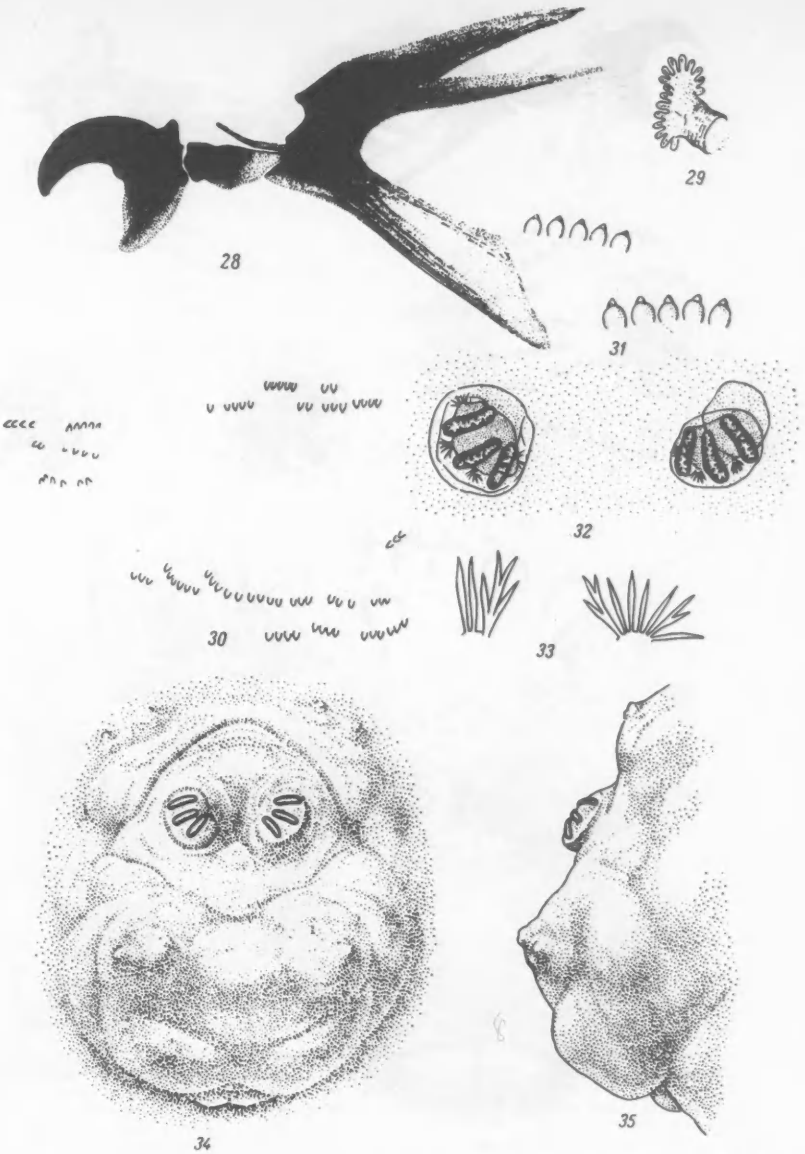
and gathered into clusters of ten to fifteen. Two pairs of clearly marked tubercles on the hind body segment, one above the spiracles and the other, consisting of larger, biapiculate tubercles, situated between the spiracles and the anal orifice. Anal lobes circular, slightly protuberant. Length of full-grown larva 6.5-8 mm.

The description is based on material collected in vicinity of Alma-Ata from hips of Rosa alberti Rgl.

4. Zonosema turanicum Rohdendorf (Figs. 28-35).

The larvae are a dirty yellow color and fairly large, structurally resembling Z. alternatum (Flln.) larvae. Preoral furrows well developed and distinct; preoral teeth lacking; mandibular sclerites very massive, lunulate; processes of pharyngeal sclerite large, more than twice as long as the basal width of the sclerite. Anterior spiracles with 15-16 tubules. Body segments separated by small furrows consisting of foveae, as in Z. alternatum (Flln.). Dorsally along the anterior margin of the thoracic segments are irregular short rows of spinelets. The spines on the abdomenal segments not numerous and occurring only on the ventral folds; they are small but broad-based. Slits of the posterior spiracles short but two and a half to three times longer than their width. Interspiracular processes large, partly branching, lanceolate, in groups of five to eight. Two pairs of small tubercles above the spiracles; one pair of larger, biapiculate tubercles below them. Length of full-grown larva 7-7.5 mm.

The larvae develop in the pulp of Rosa spinosissima L. hips and were collected in the



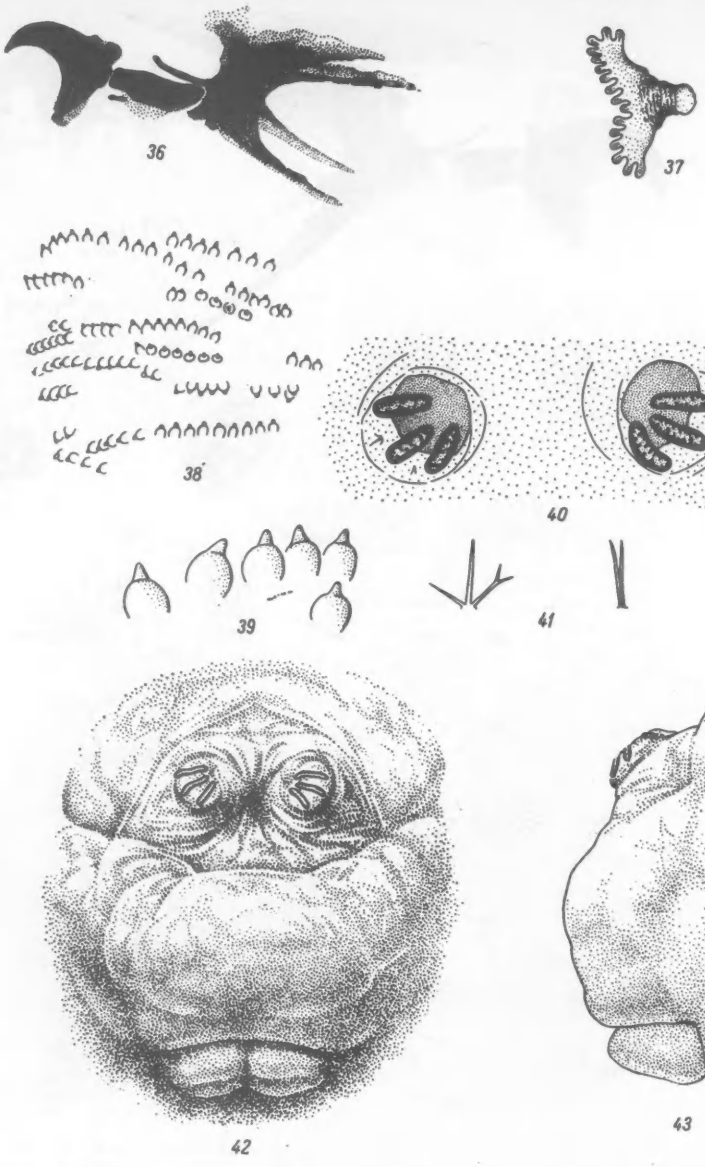
Figs. 28 - 35. Zonosema turanicum Rohd. (orig.). 28 - stomatopharyngeal apparatus; 29 - anterior spiracle; 30 - arrangement of spines on abdominal segments; 31 - structure of spines; 32 - posterior spiracles; 33 - interspiracular processes; 34 - structure of posterior extremity of larva, rear view; 35 - the same, lateral view.

vicinity of Alma-Ata.

5. The barberry fly (Zonosema meigeni Loew) (Figs. 36-43).

Larvae white, slightly narrowed anteriorly, arcuate. No preoral teeth. Oral aperture surrounded by very clearly defined preoral furrows. Mandibular sclerites crescent-shaped in the apical half, massive and without teeth on the concave ventral margin. Pharyngeal sclerites broad, with narrow, relatively short posterior processes, the length of which is only just greater than the width of the basal part of the sclerite. Anterior spiracles with 16 short, round tubules. Abdominal segments (second to eighth inclusive) with broad transverse folds ventrally, on which are numerous irregular, discontinuous rows of spines. The transverse folds on the thoracic segments and the first abdominal segment barely visible; here the spines are not numerous and are gathered into short arcuate rows. The spines themselves short and broad-based, slightly longer than wide. Distance between the posterior spiracles roughly equal to the diameter of the spiracle. Length of the spiracular slits in the posterior stigmata two and a half to four times their width. Superior spiracular slits horizontal and straight or slightly depressed at the exterior extremities. Interspiracular processes slender, sharp, sometimes branched, arranged singly or in groups of two or three. Eighth abdominal segment convex, smooth and without tubercles around the spiracles. Anal lobes slightly prominent, circular, thickening apically. Length of full-grown larva 7-8 mm.

The larvae develop in barberry seeds. Described



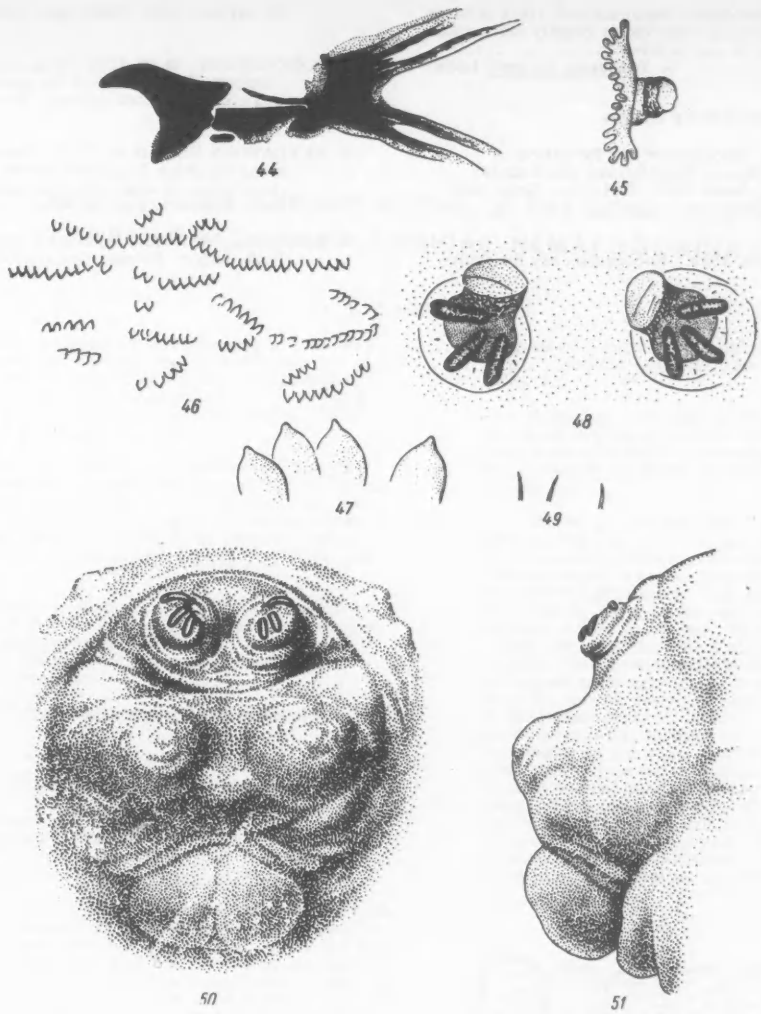
Figs. 36 - 43. Barberry fly (~~Zonosema meigeni~~ Loew) (orig.). 36 - stomatopharyngeal apparatus; 37 - anterior spiracle; 38 - arrangement of spines on abdominal segments; 39 - structure of spines; 40 - posterior spiracles; 41 - interspiracular processes; 42 - structure of posterior extremity of larva, rear view; 43 - the same, lateral view.

from material collected from Berberis vulgaris L. in Leningrad parks.

6. Megarrhagoletis magniterebra Rohdendorf (Figs. 44-51).

Larvae white, narrowing toward the anterior extremity. No preoral teeth; preoral furrows distinct. Mandibular sclerites massive, more or less triangular, with broad bases and crescent-shaped apical parts. Processes of pharyngeal sclerites narrow, slender, their length scarcely greater than the width of the basal part of the sclerite. Anterior spiracles with 13-15 short tubules. Each body segment bearing a ring of large tubercles. A few small rows of spines around the whole of each thoracic segment and the first abdominal segment; numerous rows of spines on the remaining abdominal segments, grouped only on the ventral folds. Spines large, blunt, broadening basally, very slightly longer than wide. Posterior spiracular slits fairly narrow, three to four times as long as their diameter; the superior slit set almost at right angles to the inferior pair of slits. Interspiracular processes extremely small, hard to distinguish, separate from one another. Last body segment with a pair of large tubercles situated between the spiracular and anal tubercles. The latter are fairly large and protrude slightly. Length of full-grown larva 6-6.5 mm.

The larvae develop in seeds of Berberis



Figs. 44 - 51. Megarrhagoletis magniterebra Rohd. (orig.). 44 - stomatopharyngeal apparatus; 45 - anterior spiracle; 46 - arrangement of spines on abdominal segments; 47 - structure of spines; 48 - posterior spiracles; 49 - interspiracular processes; 50 - structure of posterior extremity of larva, rear view; 51 - the same, lateral view.

heteropoda Schrenk. Description based on material collected in the vicinity of Alma-Ata.

Key for Identification of Full-Grown Fruit-Fly Larvae

1 (4). Preoral teeth present; preoral furrows undeveloped; anal lobes large, bent downward.

2 (3). Mandibular sclerite with one large tooth on inner concave margin; 16 tubules on anterior spiracles. Larvae in pulp of sweet and sour cherries and honeysuckle berries..... 1. Rhagoletis cerasi L.

3 (2). Mandibular sclerite with two small teeth on concave margin; 10 tubules on anterior spiracles. Larvae in honeysuckle berries..... .....2. Rhagoletis flavicincta (Loew) Enderl.

4 (1). Preoral teeth lacking; preoral furrows well marked; anal lobes just protruding.

5 (8). Interspiracular processes long, grouped into bunches of more than five; anterior margin of each thoracic segment with numerous short rows of small spines dorsally; body segments separated by distinct annular furrows consisting of small foveae. Larvae in wild-rose hips.

6 (7). Rows of spines in a narrow ring around each abdominal segment; 21-25 tubules on anterior spiracles; interspiracular processes long, slender, grouped into bunches of 10-18.....3. Zonosema alternatum (Flln.).

7 (6). Rows of spines only on ventral surface of abdominal segments; 15-16 tubules on anterior spiracles; interspiracular processes lanceolate, in groups of five to eight..... 4. Zonosema turanicum Rohd.

8 (5). Interspiracular processes short, single or in groups of two or three; small number of rows of spines on thoracic segments; no annular furrows consisting of small foveae on segment borders; larvae develop in barberry seeds.

9 (10). A ring of large tubercles on each body segment; interspiracular process single, unbranched, extremely small, very difficult to discern..... ..... 5. Zonosema meigeni Loew.

10 (9). Thoracic and abdominal segments lack rings of large tubercles; interspiracular processes readily discernible, acicular, in groups of one to three..... 5. Zonosema meigeni Loew.

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CERTAIN SPECIES OF FUNGIVOROUS MOTHS OF THE GENUS NEUROTHAUMASIA LE MARCH (LEPIDOPTERA, TINEIDAE, NEMAPOGONINAE)

A. K. ZAGULYAYEV

Fungivorous moths, being mycetophagous, are not only of theoretical interest as a transitional link with keratophagous species but also have some economic importance, since such species as Nemapogon granellus L., N. cloacellus Hw., and many others are dangerous pests preying on grain crops and the products thereof.

Petersen (1957), in a paper on the palearctic Tineidae rightly distinguishes, on the basis of differences in the structure of the copulatory apparatus, a group of moths which he brackets with the genus Nemapogon Schr. In this group he includes the genus Neurothaumasia, to be examined in this paper, placing it between the genera Nemapogon Schr., and Haplotinea Diak.

The present paper is partly a revision of the subfamily Nemapogoninae and an examination of moth species grouped under the genus Neurothaumasia Le March., which live in nature but are sometimes found, especially in southern regions, in food storehouses.

The paper includes a description of the genus and of three species.

Genus NEUROTHAUMASIA Le March.

Le Marchand, 1934; 24; Amsel, 1951: 135 (Gallura); Petersen, 1957: 92-93.

Type of genus — Neurothaumasia ankerella Mn.

Related to the genus Nemapogon Schr., but differing from it by the following characters: typical markings; absence of bifurcation formed by A_2 and A_3 in the radical part of the forewing; short radiocubital cell of hind wing roughly one third as long as the wing; M_1 and M_2 seated on a short petiole running from the radial trunk; structure of the male genitalia (narrow, long harpes — without sclerotized structures; simple, short aedeagus and saccus).

Imago. Head covered with white hairs. Galeae short, not reaching the apex of the second segment of the labial palpi. Epipharynx in the form of a tongue-shaped appendage, strongly developed and readily noticeable. Pilifers large and thickly covered with long setae. Antennae two-thirds as long as the forewing. Antennal segments covered with short setae (Fig. 1).

Spread of forewings 12-23 mm. Forewing four times as long as it is wide. Fringe of hind wing longer than the width of the wing. Markings on forewings consisting of two or three broad transverse bands.

The wing venation differs from that of other genera (Fig. 2, A, B). In the forewing all branches of the radius extend towards the anterior margin. The R_4 and R_5 branches are basally close together. A_1 not well developed. The usual bifurcation formed by veins A_2 and A_3 at the wing base is lacking. A_2 is always clearly developed. Stigma present. Anterior margin of hind wing with a slight bend beyond the middle. Ven ation slightly reduced. Sc continuing to beyond midwing. Radial trunk extending to wing tip. M_1 and M_2 seated on short petiole emerging from radial trunk; M_3 lacking. Both Cu veins merging basally, forming a marked thickening, then continuing as one vein. Radiocubital cell very short, reaching only as far as one third of the wing length. A light colored band on tibiae of fore and middle legs. Tibia of foreleg (Fig. 3) short, half as long as femur. Epiphysis half as long as tibia and covered with a brush of short setae. Middle pair of hind tibial spurs situated in front of the middle (Fig. 4). Three spines apically on each tarsal

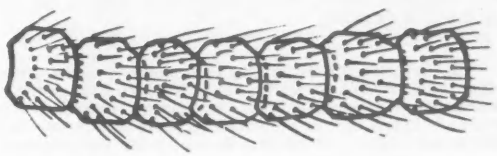

Fig. 1 - Neurothaumasia fasciata Pt. Male antennal segment.

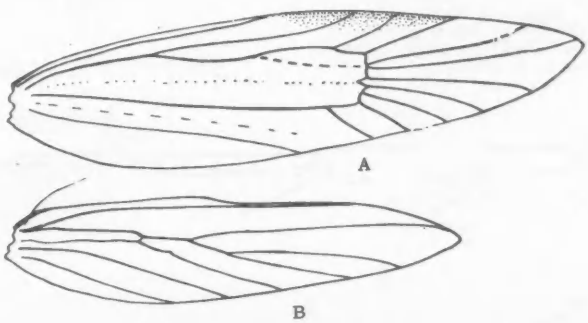

Fig. 2 - Neurothaumasia ragusaella Wck. Wing venation. A - Forewing, B - Hind wing.

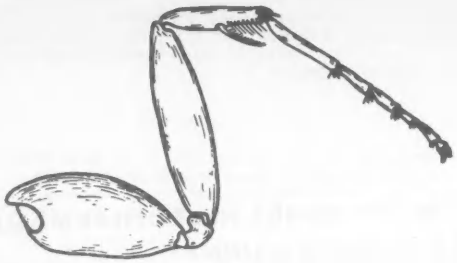

Fig. 3 - Neurothaumasia ankerella Mn. Male foreleg.

segment.

In the male genitalia the presence of narrow, long valves without digitiform processes or sclerotized hooks is characteristic. Viewed from below the uncus is indented. Aedeagus short, one fifth longer or shorter than the valves, apically membranous and without any sclerotized structures; its base is either divided or has only a slight indentation. Saccus slender and shorter than aedeagus.

Female genitalia very monotypic and characterized by a simple, entire, wide vaginal plate with a slight indentation in the middle, and the presence of a pre-vaginal plate with a concave posterior margin. The termination of the duct, like the whole of the ductus bursae, is membranous and bears no sclerotized structures. The bursa copulatrix is without a signum. Anterior apophyses forked, not reaching as far as the sixth segment; posterior apophyses extending into posterior fourth of the seventh segment. Ovipositor one and one half to two times as long as the seventh segment. Anal papillae large, with additional apophyses.

Larva. Body structure and chaetotaxy unknown.

Biology. The species are found in broadleaved forests. The larvae live in the bark and wood, mainly of old trees damaged by fungus mycelius. There are indications that the caterpillars settle and develop in old passages formed by the great capricorn beetle, where they feed on borings and saw dust affected by mold.

The moths appear from May to September in the central belt of the European Soviet Union; in Western Europe the species has two generations, in the Crimea, Caucasus and Central Asia and also in the southern parts of Europe, three generations. The older caterpillars or pupae overwinter.

Distribution. European part of the USSR, Caucasus, Central Asia; also the whole of Central and Southern Europe, the Mediterranean, Asia Minor and Iran.

The genus Neurothaumasia Le March. includes five species: N. ankerella Mn., N. ragusaella Wck., N. fasciata Pt., N. roeweri Ams., N. geratocoma Wlsm.; the two lastnamed species have been described from Sicily, Sardinia and Algeria and are not known to us in nature.

Key for Species Recognition from External Characters

1 (4). Frontal pubescence pure white; clusters of dark scales on head before and behind antennae. All three anal veins present in hind wings.

2 (3). Forewings dark brown with two broad white bands and a small white patch at base and another at tip of wing. Maxillary palpi almost twice as long as labial palpi; fourth segment of maxillary palpi three times as long as fifth..... N. ankerella Mn.

3 (2). Forewings whitish to creamy colored with three broad dark bands. Maxillary palpi short, reaching only to the middle of the second segment of the labial palpi; fourth segment of maxillary palpi equal to or slightly longer than fifth..... N. fasciata Pt.

4 (1). Frontal pubescence light brown; clusters of light colored scales on head before and behind antennae. Only two anal veins in hind wings..... N. ragusaella Wck.

Key for Species Recognition from Male Genitalia

1 (4). Aedeagus of same length as valves or shorter, with slight indentation basally. Valves narrow and four times longer than they are wide.

2 (3). Uncus viewed from below with a narrow indentation. Aedeagus widening medially and basally..... N. ragusaella Wck.

3 (2). Uncus viewed from below with a broad indentation. Diameter of aedeagus more or less the same throughout..... N. fasciata Pt.

4 (1). Aedeagus longer than valve and basally strongly bifid. Valves relatively broad, their length being two to two and one half times their width..... N. ankerella Mn.

Key for Species Recognition from Female Genitalia[1]

1 (2). Vaginal plate with a deep narrow indentation in the posterior margin. Posterior apophyses entering seventh segment. Ovipositor half as long again as seventh segment..... N. ankerella Mn.

2 (1). Vaginal plate with a shallow, broad indentation in posterior margin. Posterior apophyses not entering seventh segment. Ovipositor twice as long as seventh segment..... N. fasciata Pt.

Neurothaumasia ankerella Mn.

Mann, 1867: 75 (Tinea); Abafi-Aigner, 1900: 65 (Tinea); Caradja, 1901: 143 (Tinea); Staudinger und Rebel, 1901, II: 236 (Tinea); Spuler, 1910: 458 (Tinea); Caradja, 1931: 39, 51 (Tinea); Hering, 1932: 27 (Tinea); Osthelder, 1937: 113 (Tinea); Petersen, 1957: 93-94.

— burdigalensis Le Marchand, 1934: 24-25; 1953: 44; — tirsella Amsel, 1951: 137 (Gallura).

[1] The female of N. ragusaella Wck. is not known to us.

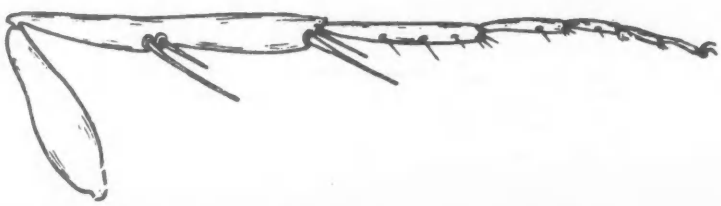

Fig. 4 - Neurothaumasia ankerella Mn. Male hindleg.

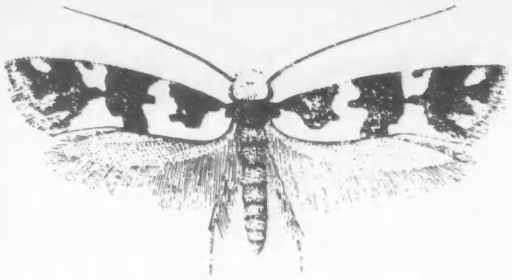

Fig. 5 - Neurothaumasia ankerella Mn. Male (drawing by Ye. Gaskevich).

Biology. Spuler, 1910: 458; Wolff und Krausse, 1922: 238.

External characters of imago: Head with tufts of black and brown scales before and behind antennae. Galeae reach middle of second segment of labial palpi. Labial palpi covered above with silvery-white, and below with dark brown, scales. Second segment half as long again as third, with a sparse brush of black setae apically and exteriorly reaching the middle of the third segment. Maxillary palpi almost twice (one and three quarters) as long as the labial and thickly covered with brown scales and hairs. Fourth segment of maxillary palpi three times longer than fifth. Eyes large, the distance between them roughly that of the longitudinal diameter of the eye. Antennae brown without rings of light scales. Length of first antennal segment more than twice its width, bearing twelve to fourteen long, brownish-black setae, which are longer than the width of the segment. Second segment one third of the length of the first and equal in length to its own width. Flagellar segments elongated, one third longer than wide.

Thorax and tegulae dark brown, shining. Wingspread of forewing of male 13-15 mm, of female 14-18 mm. Length of hind wing four and a half times its width. Fringe of hind wing half as long again as the width of the wing.

Forewings dark brown (Fig. 5) with two broad, pure white transverse bands, and with a small white patch at base and another at apex of wing. The first light band is situated approximately in the first quarter of the wing and in the anal margin merges with the

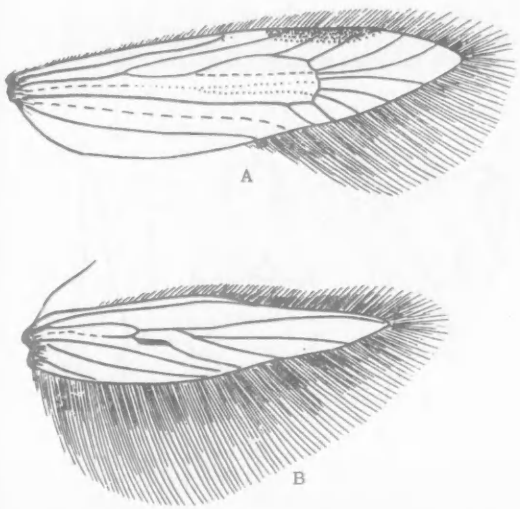

Fig. 6 - Neurothaumasia ankerella Mn. Wing venation. A - Forewing, B - hindwing.

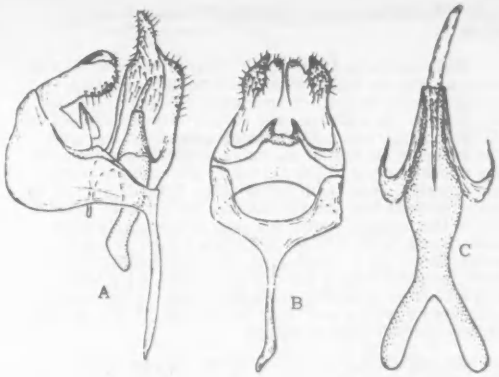

Fig. 7 - Neurothaumasia ankerella Mn. Male genitalia. A - General appearance, B - Uncus (viewed from below), C - Aedeagus (viewed from below).

patch at the base of the wing. The second light band is situated in the third quarter of the wing and is interrupted medially by a dark band of varying width. In the apical margin of the wing, mainly on the fringe, there are one or two small light smears. Coloration of hind wing golden-gray. Both pairs of wings and their fringe with a greasy shine.

Wing venation (Fig. 6, A, B): In forewing, distance between bases of R_1 and R_2 more than four times the distance between bases of R_2 and R_3. Distance from termination of M_1 to apex of wing half as much again as distance from apex to termination of R_5. Stigma very pronounced, extending from R_1 to R_3. In the hind wing all three A veins are clearly developed.

Legs dark brown and shining. Tarsi of all legs with a light band in the middle. All claw segments

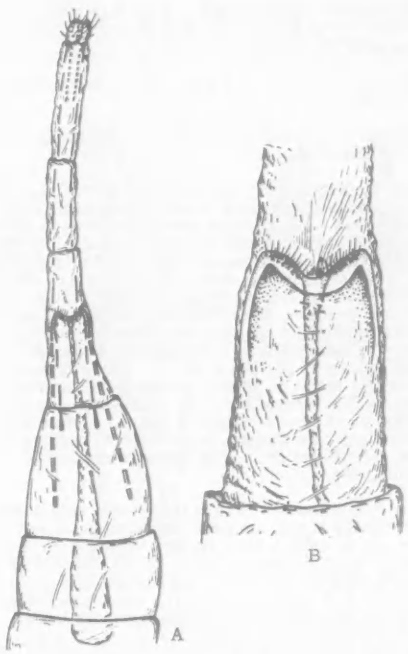

Fig. 8 - Neurothaumasia ankerella Mn. Female genitalia. A - general appearance, B - vaginal plate.

light colored apically. Abdomen brown with golden sheen.

Male genitalia (Fig. 7, A): Valves narrow, almost twice as long as wide, with characteristic prolate apical process typical of species of the genus Nemapogon Schr.; in addition, the valves have a longitudinal process on the inner side, which extends to the apex. The anterior margin of the valve slightly bent inwards. The uncus narrow in lateral view, with a blunt flabellum apically; seen from below (Fig. 7, B) all four of its apical flabella are clearly visible, with a deep indentation in the middle. Subuncus long, genicularly bent, blunt tipped, with both its branches joined by a wide membranous cord. Aedeagus of characteristic form, short, slightly longer (by one fifth) than valve and with a slender membranous apex. Base of aedeagus bifurcated when viewed from below (Fig. 7, C). Saccus slightly shorter than aedeagus.

Female genitalia (Fig. 8, A, B): Vaginal plate (Fig. 8, B) with an indentation and a large number of small setae situated marginally in two rows. Prevaginal plate with a circular indentation in posterior margin. Bursa copulatrix reaching fifth segment. One fifth of the length of the posterior apophyses entering the seventh segment. Ovipositor half as long again as the seventh segment.

In outward appearance, markings (two broad, white bands with a small white patch at base and one at apex of wing) and structure of mouth and copulatory apparatus of the male, the species can be reliably distinguished from other species of the genus.

Distribution: European part of the USSR, Crimea and Caucasus as well as the whole of Central and Southern Europe and Asia Minor. There are indications in the literature that it also occurs in Hungary (Budapest) (Abafi Aigner, 1900; Osthelder, 1937;) and in Rumania (Cardja, 1901, 1931).

Material studied: twelve males and ten females.

European USSR: Ukraine, Khar'kov, 1 ♀, 15 June 1910 (Redikortsev); Nikolayev, 1 ♂ and 1 ♀, 7 and 9 August 1933; Taganrog, 2 ♂♂ and 1 ♀, 29 June and 25 July; Crimea, 1 ♀, 16 August, 1911 (Pliginskiy); Simferopol', 1 ♀, 13 May 1922 (Redikortsev).

Caucasus: Makhachkala, 1 ♂, 2 July 1926; 1 ♂ 17 July 1933; 1 ♀ 17 September 1944 (Ryabov); Tiflis, 2 ♂♂, 7 and 28 June 1916.

Poland: Wroclaw, 1 ♂ and 2 ♀♀, 1 and 4 August 1871 (Wocke).

Hungary: 1 ♂ and 1 ♀; Budapest, 3 ♂♂ and 1 ♀, 1868-1869 (Wocke).

Biology. Infests mainly oak and also other broadleaved trees (English walnut, chestnut, beech, hornbeam, elm, sometimes linden). Although the species prefers thick trunks it infests not only trees a hundred or more years old, but also comparatively young, even slender trunks and stumps. The caterpillar lives primarily in old passages made by the larvae of the great capricorn beetle Cerambyx cerdo L. (Spuler, 1910; Wolff und Krausse, 1922; Petersen, 1957). These passages first go through the bark then into the sapwood and heartwood. The caterpillars, following these channels, travel far from the entrance openings and sometimes, completing a course of about a meter in length, pupate here or actually in the pupal cell. The caterpillar feeds on sawdust and borings, particularly if mold has developed on these. Middle and late instar caterpillars overwinter. In the central regions the species has one generation, in the southern regions (Crimea and Caucasus), two.

Economic importance. Where it has been established that the caterpillar of this moth has damaged the woody tissue in the same way as certain bark beetles (Xylerborus monographus Ratz., X. dryographus Ratz., X. saxeseni Ratz.), it can be considered as a secondary oak pest along with Platypus cylindrus Fabr. and Apate capucina L., which are found fairly often in passages made by the great capricorn beetle.

Neurothaumasia ragusaella Wck.

Wocke, 1889: 1-2 (Tinea); Staudinger und Rebel, 1901, II: 234 (Tinea); Spuler, 1910: 458 (Tinea); Petersen, 1957: 94.

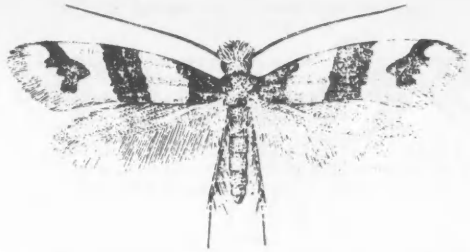

Fig. 9 - Neurothaumasia ragusaella Wck. Male (drawing by Ye. Gaskevich).

External characters of the imago: Frontal pubescence light brown. Labial palpi brownish above and dusted with black scales. Eyes large, strongly convex, the distance between them two thirds of their longitudinal diameter. Antennae dark gray, but first segment whitish.

Thorax white, tegulae basally darkened, then merging with the color of the thorax. Spread of forewing in male 14.5 mm. Length of hind wing four and one half times greater than its width.

The forewings (Fig. 9) are pure white, with three fairly wide dark brown transverse bands. The first band is the narrowest and lies at the base of the wing; the second, which is straight and wide (its length being approximately one and a half times its width) is in the middle of the wing; the third is small and curved, situated before the wing apex, i.e., approximately in the apical four fifths of the wing. The wing apex and apical margin are white. The hind wings are golden-gray. The fringe of the forewing is a dirty-white; that of the hind wing merges with the tone of the wing itself.

The wing venation (Figs. 2, A, B) is very similar to that of N. ankerella Mn. In the forewing the distance between the bases of veins R_1 and R_2 is roughly 5-6 times that between the bases of veins R_2 and R_3. Veins R_4 and R_5 are basally close together. The distance from the end of M_1 to the wing apex is six times the distance from the apex to the end of R_5. The stigma is distinct and extends from Sc to R_3. In the hind wing A_3 is either indistinct or completely lacking.

Legs yellowish-gray. Tibiae of all legs with a unicolorous band medially and apically. All tarsal segments yellowish with black spots and a light

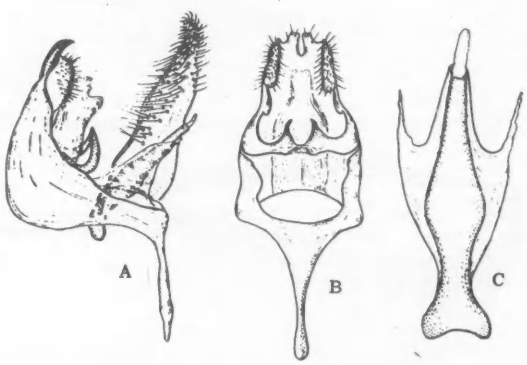

Fig. 10 - Neurothaumasia ragusaella Wck. Male genitalia. A - General appearance, B - Uncus (viewed from below), C - Aedeagus (viewed from below).

Fig. 11 - Neurothaumasia fasciata Pt. Male (drawing by Ye. Gaskevich).

colored band apically.

Abdomen grayish-yellow with a cluster of scales of the same color at the anal extremity.

Male genitalia (Fig. 10, A): Valve without a sharp apical process, narrow and more prolate than in N. ankerella Mn., their length almost four times their width. Anterior margin of valve slightly bent inwards. Uncus laterally with a hook-shaped apex and blunt flabelliform processes, densely covered with short setae; viewed from below (Fig. 10, B) all four of its apical flabella visible, with a shallow but fairly wide median indentation. Subuncus arcuate, apically sharp, its two parts joined by a bridge. Aedeagus notably shorter (one fifth) than valve. Base of aedeagus viewed from below (Fig. 10, C), widening and with only a slight indentation terminally. Saccus shorter than aedeagus.

Female unknown to us.

In external appearance, type of markings on forewings, venation and leg structure the species is similar to N. ankerella Mn., but can be reliably distinguished from it by the detail of the markings, the continuous black patch at the base and the narrow dark band falling short of the wing apex. Valve without pronounced apical process; aedeagus shorter than valve and basally widened.

Caterpillar not known.

Distribution. The species was described by F. Wocke from two specimens taken by him in a house in Palermo (Sicily) on the outskirts of the forest, under artificial light on a July evening in 1889.

Material studied. The only available specimen, a male in the Wocke collection with a square green label and the notation "Palermo 89. Rag." was studied. Examination of this specimen fully corroborates the diagnosis given in Wocke's original description (1889).

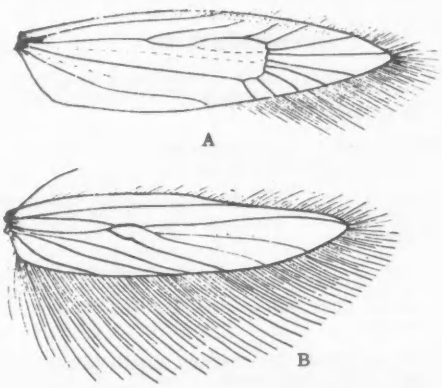

Fig. 12 - Neurothaumasia fasciata Pt. Wing venation. A - Forewing, B - hindwing.

Fig. 13 - Neurothaumasia fasciata Pt. Hindleg.

Petersen (1957), having no possibility of familiarizing himself with the Sicilian specimen, threw doubt not only on the distinction between this species and N. ankerella Mn., but also on its independent status as a species. We, on the basis of studying the Sicilian specimen in our institute (one of two known specimens of Tinea ragusaella described by Wocke) believe that the independent status of this species cannot be doubted and accept the specimen in the Zoological Institute, Leningrad as the species type.

Biology unknown; it can be assumed that the caterpillars live on tree fungi, in bark or decayed wood.

Neurothaumasia fasciata Pt.

Petersen, 1959: 565-567.

In general shape this is similar to N. ankerella Mn. and N. ragusaella Wck.

External characters of imago: Clusters of gray scales on head, before and behind antennae. Galeae just reaching basal third of the first segment of the labial palpi. Labial palpi superiorly covered with grayish-yellow or brown and black shining scales; basal half of third segment darker. Second segment a quarter as long again as the third. Setae on apex of second segment reaching the middle of the third segment. Maxillary palpi short, reaching approximately the middle of the second segment of the labial palpi. Fourth segment as long as the fifth or very slightly longer. Eyes large, strongly convex; the distance between them roughly three quarters of the longitudinal diameter of the eyes. Antennae dark brown, without bands of light colored scales. Length of first antennal segment two and a half times its width; anteriorly this segment bearing twenty to twenty-two blackish setae, which are longer than the

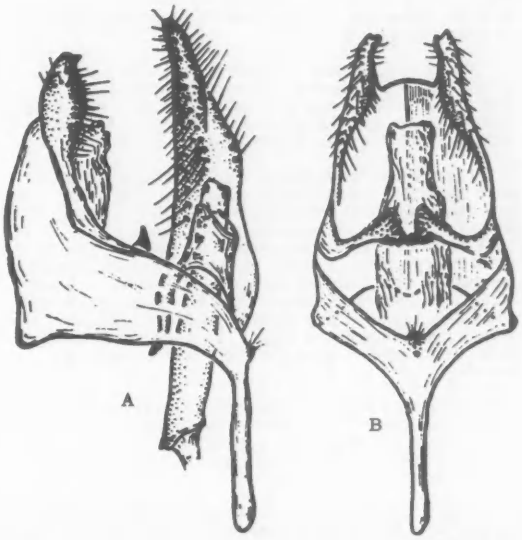

Fig. 14 - Neurothaumasia fasciata Pt. Male genitalia. A - General appearance, B - Uncus viewed from below.

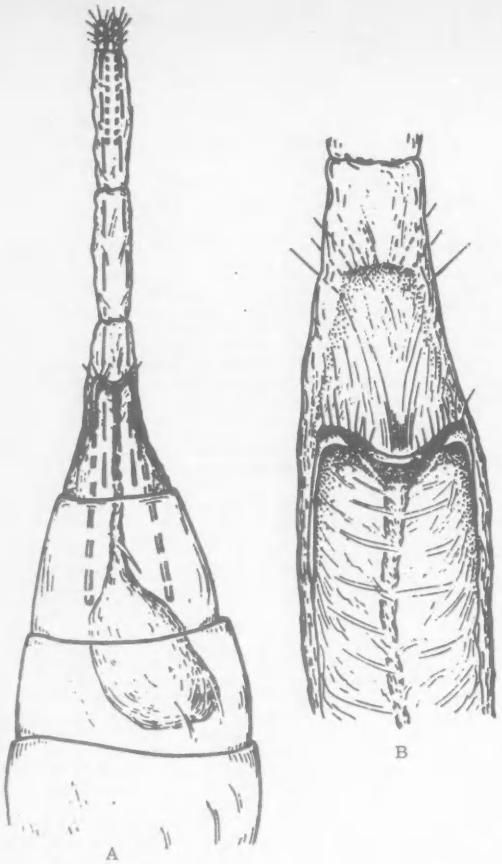

Fig. 15 - Neurothaumasia fasciata Pt. Female genitalia. A - General appearance, B - vaginal plate.

width of the segment. Second segment less than one third as long as the first and slightly shorter than it is wide. Flagellar segments short, broad and slightly longer than wide.

Thorax and tegulae blackish brown, with a small quantity of lighter scales. Spread of forewings 12-13 mm in male, 13-23 mm in female. Length of hind wing four times greater than its width. Fringe of hind wing roughly one and a third times the width of the wing.

In regard to the forewing markings the species here described resembles N. ragusaella Wck. The forewings (Fig. 11) are whitish-cream in color with three broad, dark, brown transverse bands. The first band occupies the wing base, its width varying in different specimens, but the band is invariably present and clearly defined. The second band is more or less straight, a good deal wider than in N. ragusaella Wck. (its length being roughly equal to its width), and situated in the middle of the wing. The third band is very wide and occupies almost the whole apical region of the wing.

The extreme apex and the apical margin of the wing (merely the fringe) are of the same coloration as the basic tone of the wing. The coloration of the hind wings is golden-gray. The forewing fringe is light cream, the hind wing fringe grayish.

Wing venation (Fig. 12, A, B) is very like that of N. ankerella Wck.; distance between bases of R_1 and R_2 more than four times the distance between these veins. R_5 approaches very near the apex of the wing, as in N. ragusaella Wck. Distance from end of vein M_1 to wing apex roughly five to six times the distance from apex to termination of vein R_5. A_1 not very pronounced. Stigma long, extending from Sc to R_4. A_3 clearly developed in hind wing.

Legs dark brown, shining. Tibiae of first and second pairs of legs with three light-colored bands situated at the base, middle and apex. Hind leg tibiae yellowish-gray. All tarsal segments apically light-colored. First to third tarsal segments bearing setae on the under side (three on first segment, one each on the second and third; Fig. 13).

Abdomen brown and gray with a golden sheen.

Male genitalia (Fig. 14, A): Valves narrow, long, with prolate apex, their length roughly four times their width. Uncus laterally bluntly pointed, without flabelliform processes; viewed from below only two lateral flabella are visible, with a fairly deep, wide indentation between them (Fig. 14, B). Subuncus apically blunt. Aedeagus equal to or shorter than valve, constituting a more or less uniform tube slightly narrowing apically and with very slight indentation or none at all in its basal part. Saccus scarcely more than one quarter the length of the aedeagus.

Female genitalia (Fig. 15, A, B): Structurally very similar to those of N. ankerella Mn. Bursa copulatrix entering sixth segment. Posterior apophyses not reaching seventh segment. Ovipositor twice as long as seventh segment.

N. fasciata Pt., in general shape is reminiscent of N. ankerella Mn. and N. ragusaella Wck. but differs slightly from these in having very short galeae and maxillary palpi, wide median and apical bands on forewings, claspers without an apical process, uncus with only two lateral flabella and a wide indentation between them.

Caterpillar unknown.

Distribution: Central Asian Republics and Iran.

Material studied: Fifteen males and six females.

Central Asia: Uzbek SSR, Samarkand, 1 ♂ 25 May and 1 ♀, 21 July 1892 (O. Herz); Chirchik, 1 ♀, 8 June 1924 (O. Martynova); Turkmenian SSR Kara-Kalinsk District, Igdedzhik, in daylight, 12 ♂♂ and 3 ♀♀, 26-27 May, 23 June, 24 August, 1952 and 18 May, 7 June 1953 (V. I. Kuznetsov); Sumbar River District, 1 ♂, 10-22 July 1894 (Herz); Tadzhik SSR, Kondar Gorge, 1100 meters (Varzob District) 1 ♀ 17 August 1945 (Gussakovskiy).

Iran, Mula-Kara, 1 ♂, 10 May 1894.

Biology. The species is found in mountain desert zones at altitudes above 1000 meters. The moths have been caught in May/June and in August in old forest plantations or old fruit orchards. The species seems to have two generations. It can be assumed that the caterpillars of this species feed on wood fungi, rotten wood and possibly dried-out fruit.

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A NEW GENUS AND SOME NEW SPECIES OF GAMASID MITES FROM NORTH VIET-NAM AND SOUTH CHINA

N. G. BREGETOVA and I. M. GROKHOVSKAYA

In the course of work on collections of small-mammal ectoparasites from North Viet-Nam and South China, new forms of gamasid mites were discovered. These are described below.

The North Viet-Nam collections were made in 1956 by Soviet and Vietnamese experts. The following members of the staffs of Hanoi University and of the Institute of Epidemiology and Microbiology, USSR Academy of Medical Sciences, took part: Nguen Son Hoe, Dan Van Ngy, Do Kin Tung, To Kim Tang, I. M. Grokhovskaya. The rodents were identified by Professor Dao Van T'ien of Hanoi University.

The South China collections were made in 1957 by an expedition of the Chinese People's Republic Academy of Sciences in southwest Yunan. The rodents were identified by Professor Shou Tseng Huan.

The work on the Vietnamese material was done by I. M. Grokhovskaya, that on the Chinese material by N. G. Bregetova.

A new genus of the family Laelaptidae was discovered, with one new species, and two new species of the genus Hirstionyssus, which proved common to the fauna of both North Viet-Nam and South China.

The material is preserved in the collections of Hanoi University, the Institute of Zoology (Chinese Academy of Sciences), the Department of Focal Infections, Institute of Experimental Medicine, USSR Academy of Medical Sciences and the Institute of Zoology, USSR Academy of Sciences.

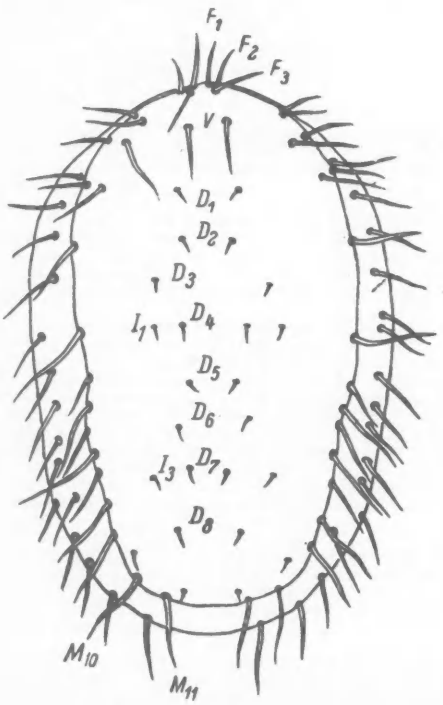

Fig. 1 - Rhyzolaelaps inaequipilis, gen. et sp. n., Female, dorsal view.

RHYZOLAELAPS Bregetova et Grokhovskaya, gen. nov.

Similar to Haemolaelaps Berlese, but differing in the structure of the chelicerae and gnathosoma of the full-grown mites and nymphs, the number of setae on the genitoventral plate of the female and the II-leg equipment of the male.

As regards the shape of the sternal, genitoventral and anal plates, as well as the number of setae on the genitoventral plate, the genus resembles the neotropical genus Steptolaelaps Furman, but differs greatly from this in regard to the chaetotaxy of the body, plates and extremities and the structure of the chelicerae and gnathosoma.

The plate structure of the protonymph, deutonymph, male and female is the same as in Haemolaelaps, but there are three pairs of setae on the genitoventral plate of the female instead of one. The gnathosoma has a very broad epipharynx, with the result that the hypostomal flabella, provided with narrow teeth, are drawn well apart and to the sides. In the deutonymph and female the structure of the chelicerae is peculiar: in addition to the usual transparent appendage, the pilus dentilis, the chela bears an extra one, which spreads apically and extends above the chelae. The male chelicera bears a spermatodactyl, as in Laelaps and Haemolaelaps.

Generic type: Rhyzolaelaps inaequipilis, sp. n.

Rhyzolaelaps inaequipilis, sp. n.

Female: Body length 0.91-1.1 mm. With the egg, the female body is broadly ovate; otherwise it is slightly constricted behind. Scutum large, covering the greater part of the body superiorly, with 33 pairs of sharply heterogeneous setae; those on the anterior part of the scutum (F_{1-3}, V) and on its margin are large, many of them undate; the other 12 pairs are short and slender (Fig. 1). The sternal plate is broad, with almost straight or slightly concave ventral and dorsal margins; its angles merge with the intercoxal plates and are slightly extended; on the scutum are three pairs of long, acicular setae and two pairs of narrow, slit-like organs (Fig. 2). Metasternal plate narrow and long; Mst setae on their interior margin. Genitoventral plate smallish, with transparent genital valve and three pairs of setae at the very edge of the plate. Anal plate narrow, inversely pyriform. Anal orifice in anterior part of shield; Ad setae behind this opening. All ventral-surface setae are long and acicular. Inside the body are large, translucent, retort-shaped spermathecae, giving off narrow ducts anteriorly which emerge in the region of the III-IV coxae.

Tritosternum has a broad stipes and laciniae densely covered with plumose hairs. The gnathosoma is broad basally and the hypostomal furrow has six rows of teeth (the rows, from top to bottom, contain 2-3-2-2-3-2 teeth respectively);

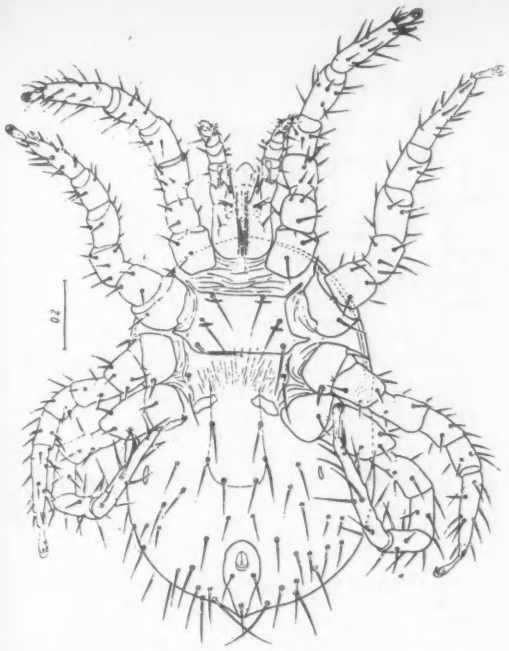

Fig. 2 - Rhyzolaelaps inaequipilis, gen.et sp. n. Female, ventral view.

the interior hypostomal setae (C_3) are somewhat longer, the anterior (C_1) practically the same size as the gnathosomal (C_4), the exterior (C_2) shortest of all. Cornicles narrow and apically sharp. Epipharynx broad, linguiform, with a fine longitudinal shading and extremely small denticles apically. Interior hypostomal flabella wide apart and laciniated (Fig. 3). Salivary stylets narrow, transparent, shorter than epipharynx. Tectum membranous, with rounded anterior margin. Palpi bear, in addition to the usual acicular setae, a membranous seta of varying shape on the trochanter (tr_1) and a pair of setae, slightly apically dilated, on the genu (g_1 and g_2). Chelicerae with very peculiarly shaped chelae (Fig. 4): a transparent appendage, elevated above the chelae as in the males of a number of genera, running from the base of the movable digit; a corona of setae at the base of the chelae well developed; the movable digit broader than the other, carrying two large teeth and apically hooked; the fixed digit with a small tooth at the apex; the pilus dentilis broadening from base to apex and with a few thin spines on the margin.

The anterodorsal spine on the II coxae is short and sharp; the setae on coxae III are slightly thicker than those on coxae I, II and IV. The setae on the claws II are slightly thickened. The femoral setae are hardly distinguishable from the rest.

Male. Somewhat smaller than female, with a body length of 0.68-0.78 mm. As in the female, the dorsal shield setae are not uniform (Fig. 5, a). There is one slightly sclerotized plate on the ventral side, extending behind coxae IV and slightly constricted before the anal opening; it bears 12 pairs of setae and one unpaired long seta. Lateral ventral (metapodal) plates smallish and irregularly ovoid (Fig. 5, b).

There is a blunt spine on the outer side of the femur of leg II; the coxae and claws of all legs are without spines or thickened setae (only the anterior seta on the coxae III is slightly thicker than the rest). Chelicerae shaped as in Laelaps and Haemolaelaps; spermatodactyls long, apically

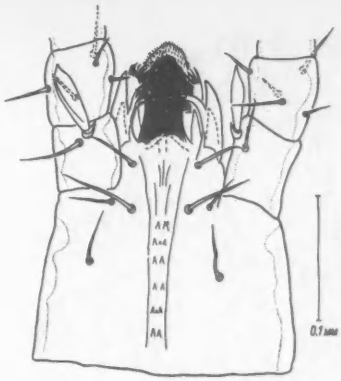

Fig. 3 - Rhyzolaelaps inaequipilis, gen. et sp. n. Female gnathosoma.

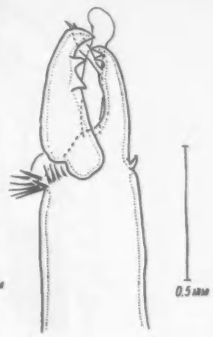

Fig. 4 - Rhyzolaelaps inaequipilis, gen. et sp. n. Female chelicerae.

curved.

The mites are parasitic on various species of the bamboo rat (genus Rhyzomys); males, females, deutonymphs and pronymphs were collected from these rodents.

Place and time of collection: hosts: North Viet-Nam, Ha-Giang province, near the town of Ha Giang (19 May and 31 June 1956); on Rhyzomys pruinosus Bl.; Kuang Tri province, Vinh-Ling (11 August 1956) on Rattus concolor Bl.; Kao Bang province, Tin-Tuk settlement (23 March 1956) on R. rattus flavipectus M. E. South China: Yunnan province, Cheli (March 1957) on R. sumatrensis cinereus McClelland.

Hirstionyssus callosciuri, sp. n.

Resembles Hirstionyssus liberiensis (Hirst) in having a large hook on the II coxae but differs as to the structure of the II claws, thoracic scutum and other characters.

Female. Body length 0.46-0.56 mm. Mites pyriform after feeding. Dorsal scutum of replete mite does not cover a great deal of the top of the body; posterior margin of scutum broadly rounded; 26 pairs of very short, fine setae on scutum (F_1, F_3, V, D_{1-8}, T_1, ET_{1-2}, Sc, Sc_{1-8}, I_{1-2}, M_{11});

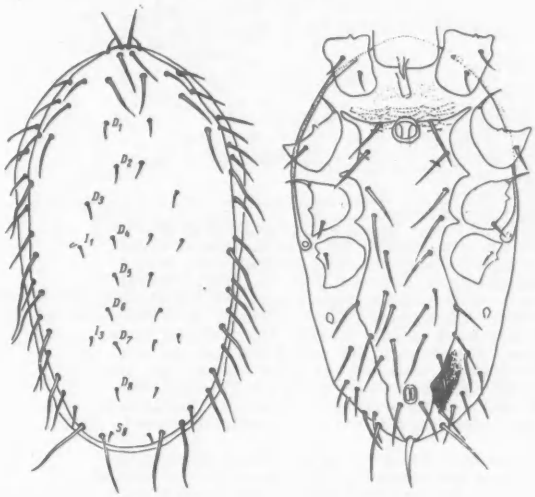

Fig. 5 - Rhyzolaelaps inaequipilis, gen. et sp. n. Male: a - dorsal view; b - ventral view.

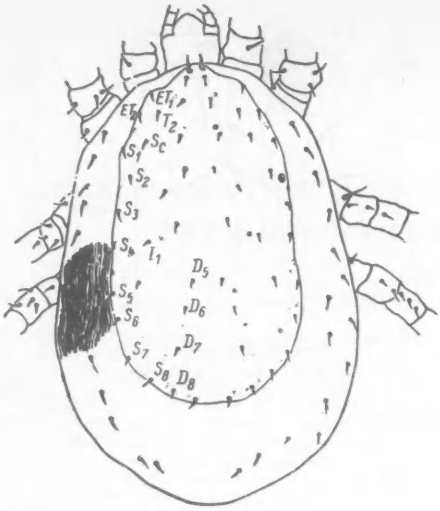

Fig. 6 - Hirstionyssus callosciuri, sp. n. Female, dorsal view.

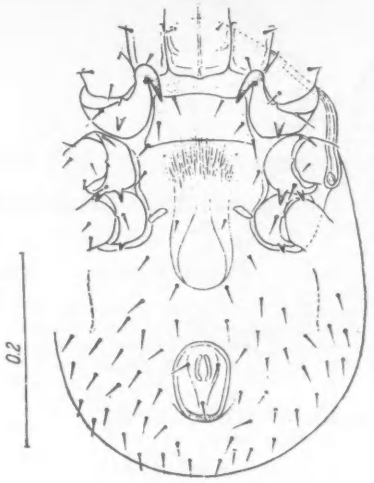

Fig. 7 - Hirstionyssus callosciuri, sp. n. Female, ventral view.

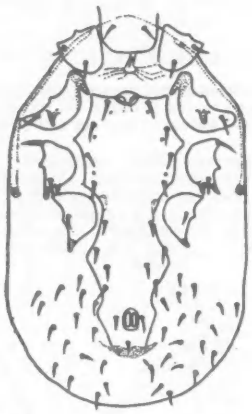

Fig. 8 - Hirstionyssus callosciuri, sp. n. Male, ventral view.

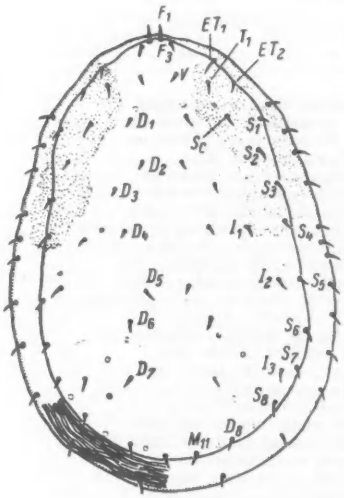

Fig. 9 - Hirstionyssus indosinensis, sp. n. Female, doral view.

M_{11} just longer than the other setae (Fig. 6). Sternal plate trapezoidal, with straight or almost straight posterior margin; anterior and posterior angles slightly extended (Fig. 7). Genitoventral plate with a broadly rounded posterior margin and a wide, transparent anterior margin. Anal plate with broadly rounded anterior and posterior margins. The setae on that part of the body surface which is not protected by a plate vary in size, the dorsal setae being very small (12-15 pairs), the ventral ones large (roughly 20 pairs). Peritremes long, extending forward to the middle of coxae I.

Legs short and thick; on coxae II the anterior seta has been transformed into a large hook-shaped process; the posterior seta is normal and acicular, the anterodorsal spine smallish, sharp; the ventral spine is larger than the spines on the coxae III; there is a smallish spine on coxae IV. Formula for coxal spines: 0-3-2-1. Two thickened apical setae on claw II. Femoral setae of leg I short, the interior one being half as long again as the exterior one.

Male. Body length 0.37-0.40 mm. Dorsal scutum ovate and large; leaving only a narrow band of the body unprotected. Ventral plate widening out behind coxae IV, then narrowing just before the anal plate; scutum with nine pairs of setae and one unpaired seta; angular processes on level of anal setae (Fig. 8). About 20 pairs of setae on that part of the ventral surface which is not protected by the scutum. Legs equipped as in the female. Chelicerae grooved; movable digit wide and longer than fixed digit.

Parasitic on the red-bellied squirrel Callosciurus erythreus erythrogaster Bl. and the Indian gray squirrel C. pygerythrus imitator Thomas.

Place and time of collection and hosts: North Viet-Nam, Nge-An province, Phu-Cui settlement (11 September 1956)

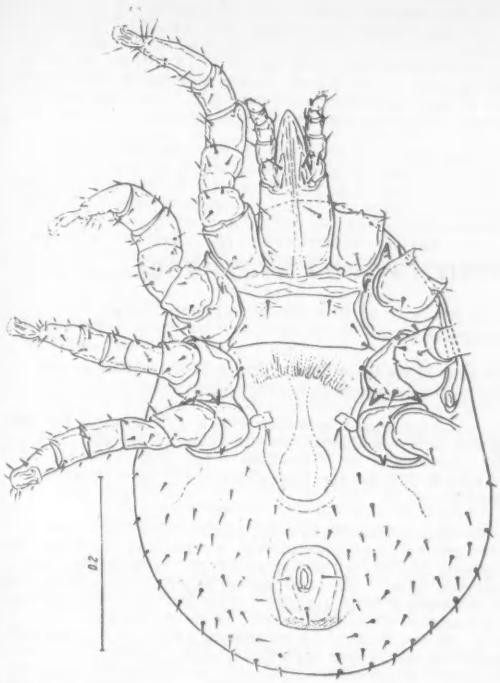

Fig. 10 - Hirstionyssus indosinensis, sp. n. Female, ventral view.

on C. erythreus erythrogaster Bl. South China: Yunnan province, Hsiaomonyang (March 1957) on C. pygerythrus imitator Thomas.

Hirstionyssus indosinensis, sp. n.

Resembles H. callosciuri, sp. n. except that the legs are differently equipped.

Female: Body length 0.57 mm, width 0.38 mm. Body and dorsal scutum very broad, the greatest width being behind coxae IV. Scutum bearing 27 pairs of short, acicular setae (Fig. 9). Prethoracic region striated with fine lines. Sternal plate with almost straight anterior and posterior margins (Fig. 10). Anterior finely, longitudinally rugulose portion of genitoventral plate almost attaining margin of sternal plate. Anal plate large, with rounded anterior and truncated posterior margins; adanal setae at level of the middle of the anal orifice, equal in length to postanal seta. Numerous (more than 40 pairs) short, slender setae on those parts of the body not covered by plates. Peritremes extending to just before the middle of coxae I. Legs short; anterodorsal spine on coxae II, anterior seta transformed to a short, thick, hook-shaped spine, triangular ventral spine lacking, replaced by a small-

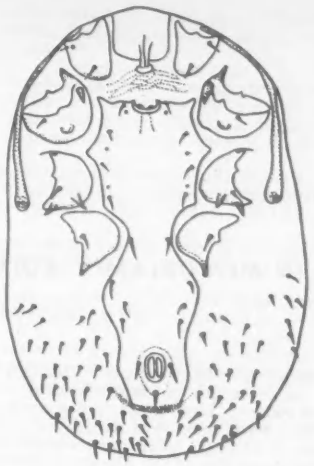

Fig. 11 - Hirstionyssus indosinensis, sp. n. Male, ventral view.

ish, blunt tubercle; two large spines on coxae III; a slender, sharp spine on coxae IV; a pair of thickened, short, apical seta on claw IV; femoral setae of leg I short and of equal length.

Male. Body length 0.48 mm. Dorsal scutum covers entire dorsal surface and is broadly rounded posteriorly. Ventral plate greatly narrowed between coxae IV and slightly narrowed in front of the anal area; nine pairs of setae and one unpaired postanal seta on the plate; the apex of the postanal seta not extending beyond the area of the shield; adanal setae at level of anterior part of anal orifice (Fig. 11). Coxae and claws of legs II equipped as in the female. Chelicerae sturdy; movable digit broad, grooved and slightly longer than the other, with a slightly recurvate, rounded apex.

Place and time of collection and hosts: North Viet-Nam, Hongaia province, settlement of Halam (31 January and 3 February 1956) on Rattus sabanus spp. ?; Kao-Bang province, settlement of Tin-Tuk, on R. rattus flavipectus; Thanhhoa (22 September 1956) on Suncus murinus. South China: Yunnan province, Fohai, (March 1957), on Callosciurus macclellandi Horsf. and C. swinhoei M.-Edwards; Puwen (April 1957) on C. swinhoei.

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IN MEMORIAM VLADIMIR VEN'YAMINOVICH POPOV (1902-1960)

A. A. SHTAKEL'BERG

On November 3, 1960, Professor Vladimir Ven'yaminovich Popov, one of the Soviet Union's leading practical entomologists, died suddenly from an acute myocardial infarction. Professor Popov was Director of the Higher Insect Laboratory of the Institute of Zoology, USSR, Academy of Sciences, a member of the Presidium of the All-Union Entomological Society, a member of the editorial board of this journal (Entomologicheskoye obozreniye), a corresponding member of the USSR Academy of Sciences and a Doctor of Biology.

Bladimir Popov was born on 20 September 1902 at Sim in the guberniya of Ufim. His father was a forester. He was educated at the Yekaterinburg Realschule, the Semipalatinsk Gymnasium and the Preparatory Department of the Urals Mining, Metallurgy and Practical Institute. In 1927 he completed the course of higher studies at the Entomological Department of the Institute of Applied Zoology and Phytopathology in Leningrad.

In 1919-1920 he served as a clerk in various medical units of the Red Army and from 1920 to 1924 he worked on the scientific staff of the Urals Province State Museum in Sverdlovsk and later as Deputy Director of its Entomological Department. From there he was sent to continue his education at the Institute of Applied Zoology. After graduating from the Institute in 1927 he entered the Zoological Museum (Zoological Institute after 1930) of the USSR Academy of Sciences as a technician, engaged at first in preparing, later in preparing and restoring specimens. In 1930 he became a Scientific Officer, Grade II, in 1933 a Scientific Officer, Grade I, in 1940 a Senior Scientific Officer in charge of the Hymenoptera Department, in 1948 Director of the Department of Land Invertebrates and June, 1960, Director of the Higher Insect Laboratory of the Institute of Zoology, USSR, Academy of Sciences.

In 1938, on the recommendation of the Institute of Zoology (USSR Academy of Sciences), his thesis for the Degree of Candidate in Biology was accepted, on the basis of his work as a whole, without his being called upon to defend it. In 1943 he defended his thesis for the Degree of Doctor of Biology and in 1950 was granted the academic title of Professor. In 1953 he was elected as a corresponding member of the USSR, Academy of Sciences in Entomology.

Professor Popov played an energetic part in a number of zoological and parasitological expeditions of the USSR Academy of Sciences and other institutes (1928-Central Kazakhstan; 1930-South Turkmenia; 1931-Armenia; 1932-Northeast Kazakhstan; 1933-Tadzhikistan; 1934-Southwest Turkmenia; 1937-Uzbekistan; 1938-Uzbekistan and Kirgizia; during the evacuation, in 1943-1944, he was in charge of station research in Tadzhikistan; in 1946 and 1948 he again worked in Tadzhikistan and in 1949 in Northwest Kazakhstan). In 1955 and 1956 he was the leader of the Soviet team in the Joint Sino-Soviet Expedition to Southwest China.

In 1956 he took part in the Tenth International Congress of Entomology in Canada and in 1957 in the Third Congress of the International Union for the Study of Social Insects in Paris, in both cases as head of the Soviet delegation. In 1959 he was sent to Poland to study the Radoszkowski collections of Hymenoptera. In 1960 he attended the Eleventh International Congress of Entomology in Vienna.

In 1933-1935 he was elected member and treasurer of the Management Committee of the Russian (now All-Union) Entomological Society. In 1944 he was elected Scientific Secretary of the Society and from 1948 until his death he was a member of its Presidium. From 1949 to 1952 he was editor of the Entomologicheskoye obozreniye.

Professor Popov held the Orders of Worker of the Red Flag and Badge of Honor, and a number of medals, as well as the charters of the Presidium of the Supreme Soviet of the Tadzhik SSR and the Presidium of the USSR Academy of Sciences.

Professor Popov was a very great authority in his chosen subject, the Systematics, morphology, ecology, zoogeography and biology of Hymenoptera, in particular and primarily, bees. His contribution to the study of this group was immense and his approach to the material was astonishingly many-sided and thorough. He described three new tribes, 26 new genera and subgenera, 101 new species and subspecies and 34 new varieties and aberrations. An indefatigable naturalist and energetic participant in many expeditions, often in very inaccessible regions, he was at the same time outstanding as a desk scientist, distinguished for his exceptional industry and capacity for work. His work, precise and meticulous, was based on strikingly faultless argumentation backed by an immense amount of evidence. Although he was always, especially in recent years, overburdened almost to the breaking point with administrative and organizational matters, many of which were fairly remote from his own interests, he gave all his spare time—every vacation, every day off—to his own subject.

A man of rare purposefulness and exceptional dedication to his own chosen subject, Popov devoted the greater part of his 120 or more published works to the study of bees, on which he was a recognized and undisputed authority. A fine morphologist and taxonomist, he also set the ecological study of bees in the USSR on a firm basis, in particular as regard the role of bees in plant pollinization. The practical value of his work in this field is very great. He and his pupils and successors have demonstrated the predominant role of wild bees in pollinating certain crops, particular lucerne, and the consequent necessity for careful attention to this group of animal organisms.

As a biological evolutionist in the very best sense of the word, Vladimir Popov produced a number of interesting studies on the evolution of parasitic bees, the establishment of parasitism among bees and the interrelated evolution of bees and the flowering plants visited by them. He was a great expert on the bee fauna of Central Asia and was able to settle many problems in regard to its origin and genetic connections, subjects in which he had a lively and particularly close interest. He has left us an almost definitive basic work, a general catalogue of Central Asian bees, which in a sense sums up these labors. This work must be published in the very near future.

During the last ten to fifteen years of his life, Professor Popov directed a great deal of work in entomology and zoology in general. This work was not always easy or congenial and drained much of his strength and energy. His great tactfulness and modesty, combined with his high sense of duty, sometimes made such work particularly exacting. Despite these more emotional qualities he knew how to be firm when matters of principle were at stake. This firmness more than once proved an invaluable asset to the great association of entomologists, the Department of Entomology of the USSR Academy of Sciences Institute of Zoology to which he gave such balanced and self-effacing leadership throughout the last twelve years.

Professor Popov was much concerned with the education

of the young scientific worker. As he himself said in one of his reports, "there is no higher, and at the same time patriotic, task than to introduce to creative scientific work a beginner in research who has come to you as the scientist and who trusts you as a scientist, as a guide and as a man." This task he performed with rare purposefulness, and he enjoyed the unlimited confidence of Soviet biologists of all generations.

In his dealings with all who were in contact with him Vladimir Popov always showed great mental sensitivity. Never shutting himself up within the narrow limits of his own special subject he showed a lively interest in problems of general biology and of science as a whole. He had a good knowledge and fine understanding of art and literature and was gifted with a highly personal and characteristically gentle, unmalicious sense of humor.

Professor Popov's untimely death is a severe loss to Soviet entomology and to all who knew him, whether personally or otherwise.

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REVIEWS AND BIBLIOGRAPHY

THE SOVIET LITERATURE ON OESTRIDAE S.L. (DIPTERA), PUBLISHED IN 1958 AND 1959

K. YA. GRUNIN

The literature on Oestridae published in the Soviet Union during 1958 and 1959 comprised 103 titles, 68 of which appeared in 1959. Table 1 shows a breakdown of these titles by main topics.

Nearly all the papers concern flies attacking domestic animals; only a few contain information on those attacking wild animals: Grunin (883)[1], Grunin (1683), Dordzhiin, Zhirnov, Kim, Shubin. Five papers describe cases of parasitism by Oestridae larvae on man (Alekperova and Kerimzade, Gerasimov, Zaydenov, Pampiglione, Sergeyev). Four papers are authors' abstracts of theses (Klepin, Krivko, Mustafayev, Romasheva).

Table 1

	Morphology	Biology	Lesion	Control	Total
Oestridae, general	—	3	1	4	8
Warble flies	—	22	5	45	72
Throat botflies	—	4	5	9	18
Stomach botflies	1	2	1	1	5
Total	1	31	12	59	103

A very brief review of the more interesting new work published during the last two years should begin with the warble flies, which still claim most attention from investigators.

The degree in which cattle are infected by warble fly larvae does, of course, depend on the animal's resistance, calves and very old animals being most susceptible to infection. Lutta (151), however, after studying cattle in the Sortavala district of the Karelian ASSR, was led to the conclusion that sick animals in very poor condition do not greatly attract the female of Hypoderma bovis De Geer during oviposition. The infection rate in a herd of healthy animals was 5.44 larvae per head of cattle inspected, against 2.46 and 2.16 respectively in a herd infected with tuberculosis and brucellosis. Lutta's visual observations of the female bomb flies during flight confirmed this conclusion. Romashova (235) has published findings which are no less interesting, showing that in calves the degree of infection by warble fly larvae and the times when the fistulae appear in the skin depend on the time of calving, (Table 2). In one calf born on 12 October 1957, a single larvae formed a fistula on 28 June 1958.

According to Ivashkov (29) bomb fly larvae have been detected in the spinal canal of cattle in the Voronezh and neighboring provinces from October to April inclusive, with a peak period in January, when they were found in the spinal canal of 70 per cent of the animals at an average rate of 8.5 individuals per animal inspected; the largest number of larvae found in any one canal was 46. The larvae appear first in the sacral part of the canals and only later in the thoracic part. Orlov investigated the presence of heel fly (Hypoderma lineatum De Vill.) larvae in cattle oesophagi. The work was done in a Moscow meat-packing plant. Examination of 329 infected oesophagi revealed the presence of first-instar heel fly larvae in the oesophagi of the young animals from July to December inclusive, with a peak in October, whereas in the adult animals the maggots were found from October to February inclusive, with a peak in December. In the young animals the number of maggots in the posterior half of the oesophagus was greater than that in the anterior half, whereas the number of larvae lying head foremost was greater than the number lying tail foremost and, moreover, the latter appeared one and a half to two months later. These data, according to Orlov, contradict the hypothesis that some of the larvae penetrate the host body through the mouth. If the animals investigated had all come from the same province Orlov's data might serve as indirect evidence against this hypothesis. Further research in this direction is very desirable.

Table 2

Month born	Percentage affected	Mean number of larvae per head of cattle examined	First appearance of fistulae in skin
March	100	25.0	January
August	35	0.5	April
September	12	0.3	April

Among works on the biology of other species of Oestridae we should mention the book by Breyev and Savelyev, which sets out for the layman results of practical importance obtained from these authors' research on the biology and control of Oedomagena tarandi L. From the biology of the goat fly (Crivellia silenus Br.) Shergin (474) established that its larvae migrate towards the spine of the goat only by way of the subcutaneous connective tissue. In Kirgizia the maggots are found in the host body from June to February, with a peak period in November. In a study of the biology of the long-tailed marmot fly (Oestromyia marmotae Ged.) Grunin (883) discovered that the rate of infection by the maggots was 15 times higher in young marmots during the first year of life than in the adult animals, that the development of the larvae continues for about a month in all and that they grow under the skin of the host at the place of entry, without migration, so that the entrance is at the same time the fistula through which the larvae leaves the host. It is interesting that the males of Oestromyia marmotae Ged. congregate on mountain summits or at points of sharp fracture on mountain crests. This ensures a rapid encounter with unfertilized females flying into these places for a short period. Grunin (1683) has produced a brief summary of original and secondary data on the widespread habit of male Oestridae of congregating at certain fixed points.

During the two years many data have been published in regard to livestock losses from Oestridae. Breyev and Grunin calculate that in 1958 the USSR as a whole suffered losses to a value of 4879 million rubles, with a ratio of hide-meat-milk production loss of 1:6:12, due to bomb fly and heelfly. Their paper is also of considerable interest from the methodological aspect. Anisimov (1957) calculates that in one Ukrainian province alone an extra 35.9 million rubles worth of livestock products yield was obtained in one year as

[1] The figures in parentheses after authors' names indicate the first page number of the paper concerned.

a result of reducing cattle infection through warble fly control. According to Kamarli (48) experiment animals infected with Hypoderma bovis De Geer and Hypoderma lineatum De Vill larvae lost 6 kg weight per month, while milk losses over the same period amounted to 11.7%. In both cases animals which had been found free from the larvae were used as controls, whereas the controls should be animals which have been carefully treated against these insects. Mustafayev (1) found that 20.3% of milk yield losses in Azerbaydzhan cattle were due to second and third stage larvae in the period January to March and 23.7% to attack by free-flying heel flies. Buffaloes, according to Mustafayev are attacked only by heel fly larvae and only at the age of three years. A few cases of parasitism by warble fly larvae (species not determined) on horses were observed by Nosik; she regards an infestation of 1 horse by 18 larvae as serious.

A great many papers have been devoted to control measures. Particular attention has been paid to tests of the Soviet systemic preparation Khlorofos,[2] which during the next few years will gradually replace the DDT and hexachlorocyclohexane used in warble fly control at present. It has been found that the most promising method of using Khlorofos is external application with addition of surface-active substances against second and third stage larvae and peroral administration against migrating larvae: Ivashkov (73), Khatin and Lur'ye (9), Khatin et al. According to Ivashkov (11, 73) addition of phenothiazine to the experiment animals' food during the period when the larvae are migrating in their body reduced the number of maggots completing their migration to one third and brought about a 6-kg weight increase in the experimental animals as compared with the controls. Krovyakov has invented and successfully tested a mechanical veterinary sprayer, the VMOK-1 for mass treatment of cattles against the warble fly and gadfly females.

Makevnin has published a very interesting discovery in regard to the sheep bot fly. In the Stalingrad province, this bot fly (Oestrus ovis L.) normally has a single generation, but 1958 was an exceptionably favorable year for the species and it produced two generations. Part of the sheep bot fly population appears to have produced a second generation in Orenburg province as well, for in August, according to Klenin (1) a number of third-stage larvae were found. In his second paper (195), Klenin gives a very clear picture of the course of oestriasis in sheep. All nine works on throat bot fly control concern the sheep bot fly; two of them are on spraying methods of control: Kolomiyets et al., and Yanovich (5).

Grab, Sergeyev, Filimonov and Zaugolyshev and Chereshnev have all published papers on the stomach bot. It is very characteristic that in a case described by Sergeyev the bot larva of the man's face was moving downwards. Some new information on stomach bots is also contained in papers by Grunin (1683) and Filashevich (115); the latter is the first paper on this subject to appear in Belorussia.

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This collection of papers presented at a conference held in Prague from 13 to 18 August is prefaced by the usual introduction containing general information on the aims and program of the conference, the list of participants and the opening speeches. These were delivered by I. Maleka, representing the Czechoslovak Academy of Sciences and by the conference organizers J. Weiser and A. Guba. The main body of the volume (pp. 35-618) consists of some 70 papers followed by brief discussion. The final section contains the resolution and concluding speeches, with the names and addresses of participants from 17 countries.

The transactions have been published as a handsome volume, with an attractive dust-jacket, abundantly illustrated with photographs. Along with papers in English, German, French and Dzhechoslovak there are a great many papers in Russian. All papers and contributions to discussion have been printed in the language in which they were delivered. Section headings and a number of papers of general character appear in English and Russian, conference resolutions in English, Russian and German. Papers printed in west-European languages are followed by abstracts in Russian, those printed in Russian by abstracts in German or English. This way of presenting the conference transactions gives them a genuinely international appearance and makes the volume easier to use.

As the introduction points out, the main purpose of those who arranged this broadly conceived and well organized meeting of people engaged in biological insect-control was to lay a basis for the international cooperation essential in this work. The personal contacts made, the information exchanged about research in progress in the various countries, the arrangements for scientific contact and exchange of Entomophaga and the reports and views presented at the conference must point the way to joint work in this field by east and west in the very near future.

In his welcoming address A. Guba emphasized the necessity of arousing public interest in biological control methods, especially in Europe. Most of those present did not believe that the favored chemical method of pest control at present widely used, almost to the exclusion of any other, was always ideal; it was sometimes accompanied by disadvantageous effects, such as outbreaks of other pests, the appearance of poison-resistant forms and so forth. In the long run it would have to be gradually replaced by a combination of biological methods with agrotechnical, immunological and other ways of protecting forest and farm crops, insecticides being used only for limited periods and over restricted areas. Meanwhile, research on many sometimes interrelated factors is essential, along with detailed study of the static and dynamic aspects both of individual species and of their combinations, whether in the home country or in new distribution foci. Nowadays, the scope of the problem and the complexity of biological control methods has made the necessity for international cooperation obvious. The problem is now becoming particularly important owing to the rapid development of international air communication, through which harmful insects are spread, usually without their natural enemies. Experience has shown that quarantine arrangements could not at present be relied upon to prevent the spread of harmful insects. Biologists in the different countries must, irrespective of state boundaries or social and economic differences, concern themselves with the propagation of these insects' natural enemies.

The 70 or so papers presented at the conference fall into two groups: insect pathology and biological control. The papers were consolidated into nine symposia, in the following order: Section I: 1) Insect bacteriology, 2) Mycology, 3) Virology, 4) Protozoology; Section II: 5) Taxonomy of Insects and entomophaga, 6) Evaluation of introduction results, 7) Increased effectiveness of parasitic insects, 8) Insect monophages and polyphages, 9) International cooperation.

In the first symposium great interest was aroused by the paper by E. Steinhaus, Director of the Laboratory of Insect Pathology and Biological Control at the University of California. The bacteria used in biological control practices were classified, independently of their taxonomic position (a single species sometimes being classified under two heads) as follows: 1) non-entomogenous—in external environment, 2) intraintestinal, 3) non-sporogenous, conditionally pathogenic, 4) sporogenous, conditionally pathogenic, 5) sporogenous, consistently pathogenic and 6) sporogenous, pathogenic with crystalloid inclusions. Practical interest lay primarily in the direct use of bacteria belonging to the last of these groups; the other groups however should not be ignored. Under certain conditions the presence of provocation factors (a certain temperature, humidity, diet and so forth) or the use of "stressors" (activators) could sharply and rapidly increase the effectiveness and virulence of the bacteria. The stressors might be food-stuffs, various toxic and non-toxic substances, certain conditions of growth and so forth. For purposes of further progress in microbiological control, Steinhaus believes that the main requirement is to concentrate research on the following questions: the mechanisms of bacterial disease in insects, the dynamics of epizootic diseases, the taxonomy and nomenclature of bacteria, methods of strain preservations, methods of mass reproduction and propagation of pathogenic forms.

I. Vankova (Czechoslovakia) described methods of mass-producing virulent strains of Bacillus thuringiensis in 200 liter jars. Complete spore formation with inclusions was achieved in 5-6 days. Up to 5 g of dry spores with inclusions were obtained from 1 liter of the preparation.

K. Tumanov (France) had isolated an individual strain of B. c. var. alesti, which is distinguished by being exceptionally pathogenic to insects and by a red pigment in vitiline media, from certain strains with parasporous crystals of B. c. The presence of this pigment was particularly helpful in ordinary practical use of the bacillus in nature. It had been established that pathogenic proteinic crystalline inclusions in the bacterial spores could disappear and then reappear under certain conditions. The passage of B. cereus through the haemolymph of Galleria mellonella was accompanied by increased crystal accumulation in the haemolymph and enhanced pathogenicity in regard to the insect. Pathogenic forms of the bacillus with crystals were found almost exclusively in caterpillars with latent polyhedral disease. The author therefore suggested that there might be a connection between the formation of pathogenic crystals in the bacilli and the presence of viruses in the latent form.

A paper by Kudler, Lysenko and Hochmut (Czechoslovakia) reported on the practical use of certain strains of bacteria for biological control of Cacoecia crataegana. The epizootics had shown a focal character and had been observed only in the forest regions which had first been treated with an aerosol fog containing bacterial suspensions.

Z. Kovacevic (Yugoslavia) and N. A. Telenga (USSR) had established that the use of insecticides in sublethal doses caused outbreaks of virus, bacterial and protozoic diseases in gypsy moth, brown-tail moth and fall webworm.

This symposium contained other interesting communications

from Ya. V. Chugunin on focal cyclicity, Ye. V. Talalayev on pine moth (Dendrolimus pini) control, V. I. Poltev on the sero-diagnostics of bee diseases and O. I. Shvetsova on the biological characteristics of entomopathogenic bacteria and their use; these papers are already partly familiar to the Russian reader from Soviet journals.

The symposium on insect mycology contained four papers. N. A. Telenga reported on synergism effects in the action of pathogenic fungi (Metarrhizium anisoplia and Beauvaria bassiana) and small doses of insecticides (hexachlorocylcohexane) used simultaneously against beet pests. The muscardine infection rate was twice as high as when the entomophthorous fungi were used in isolation. Similar results had been obtained against the lesser apple-worm by a combination of white muscardine and DDT. The beetles taken from sectors in which muscardine had been used against the larvae in the previous year were characterized by pathological changes in the haemolymph and reduced fertility a quarter to two thirds as compared with the control).

In the opinion of Samsinjakova (Czechoslovakia) the most important tasks for the development of microbiological control with fungi in the present state of mycology are to clarify the species taxonomy, to study the biology of particular species, to isolate pathogenic strains and to investigate the possibility of synergism with other entomopathogenic organisms. Combination with chemical methods do not, in her opinion, for the most part, give good results.

G. Kerner (GDR) reported on the successful use against Lymantria dispar, L. monacha, Bupalus piniarius and Hyloicus pinastri of an entomophthorous fungus, Isaria farinosa, isolated from Dasychira pudibunda. Dry spores were more effective than wet ones (in water suspension). Mixing with a filler (talc or dried milk) increased mortality and accelerated the course of the disease. Increasing the dose also resulted in accelerating the disease.

A. A. Yevlakova (USSR) had studied epizootic diseases caused by Eurygaster integriceps in nature and had isolated a large number of pathogenic fungus strains. A particularly widespread fungus was Beauveria bassiana (Bals.) Vuill. Microbiological control of Eurygaster integriceps would have to be based on the creation of infection foci in the pest's natural habitats during the overwintering period.

Ten papers, —Berholdt, Gershenson, Dikasov, Schmidt and others— dwelt on a problem which is now causing much discussion among virologists, namely that of "latent" or, as Berholdt (Canada) suggests calling them, "occult" conditions of virus diseases stimulators. The term "latent" was appropriate only in connection with infection. Interest in occult virus infections has been aroused by the results of experiments in the transmission of viruses among various insects. Although the mechanism by which occult are converted into acute viruses has not yet been studied, it has been discovered that many factors and combinations of factors could act as stressors in that transformation. Virus stressors could be food, physical conditions during the growth process, chemical substances, virus infections from other insects, superinfection and so forth. Microphotographs taken under the electron microscope (magnification 50,000 - 78,000) and reproduced in the volume under review are believed by the virologists to provide much new information about the morphology of virus particles. It has been shown experimentally that the RNA extracted from tobacco mosaic virus was infectious. The same is true of DNA extracted from silkworm polyhedra. The virologists accept the Linnaean binary nomenclature on condition that the word "virus" is added as a suffix to the generic name (for example Borrelina-virus).

Interesting data were given by S. Gershenson, on the variability and latency of viruses and by P. N. Tarasevich on the nuclein exchange of Bombyx mori during polyhedral disease. These data have in the main been already published in Russian (see the collection Infection and Protozooic Diseases of Useful and Harmful Insects, 1956 and other works) and are therefore not given here.

The use of a virus instead of insecticides in spraying, although not producing so rapid an effect as poison (the action of virus infection being generally slow) has nevertheless been proved effective in experiments with Malacosoma fragile by Stretch in the USA and has provided long-term forest protection in experiments by C. G. Thompson (USA).

Observations on a granulosis epidemic in the cabbage-white butterfly (Pieris brassicae) showed that some of the caterpillars (about 1%) transmitted the disease, thereby acquiring an immunity which they passed on to their progeny. The secondary action of the virus infection in a number of generations led to the formation of a highly disease-resistant population even in F_4 (C. Rivers, U. K.).

L. Vasiljevic (Yugoslavia) has established the influence of external ecological factors on the development and course of epizootic polyhedral diseases in the gypsy moth. A high mean diurnal temperature and drought on the southern slopes of low hills are the factors which make for the most violent epizootics. Conversely, in cool mountain river valleys with high air humidity, hardly any epizootic outbreaks have been observed. It was suggested that such stations served as refuges for the pest and as reservoirs of infection in the period of its latent co-existence with a host. A stimulant of intestinal polyhedral disease isolated from the gypsy moth and applied against the brown-tail moth gave a high mortality rate. The caterpillars began to die on the 10th day, the epizootic outbreak reached its peak in the third week. In comparison with nuclein polyhedral diseases the cytoplasmatic types showed the more standard action (J. Weber, Czechoslovakia).

In fall webworm, granulosis in the occult condition was transmitted to the progeny. Artificial infection of the caterpillars with this pest caused high mortality. The incubation period lasted for 5-14 days from the moment of infection (L. Schmidt, Yugoslavia).

Polyhedral diseases from Kotochalia junodi (Heyl.) caused by artificial infection (airborne spraying) with a water suspension began to appear on the 3rd-4th day. Mortality was very high during the next two days (about 90%) provided the spraying was done during the period when the caterpillars appeared. The virus stimulator retained its virulence for several months. It was interesting that the virus stimulator was not infectious to test parasites (L. Ossovsky, S. Africa).

The discussion on viruses was very lively. Great interest was aroused by the Russian papers, particularly by that of S. Gershenson (Kiev) on the reproduction cycles of viruses, their latent co-existence with the host, their morphology and the stressors causing activation of the disease stimulators.

In the symposium on insect protozoology and helminthology the main emphasis was on microsporidial diseases (8 papers out of 9). Credit for the most recent taxonomic work on Microsporidia and for their practical use in biological insect control belongs to J. Weiser (Czechoslovakia), who delivered an introductory paper on the principles of modern Microsporidia taxonomy. Microsporidia species are in many cases found to be not strictly specific. In connection with peroral infection, under similar feeding conditions different species of insects could be infected by the same species of Microsporidia. It has been found experimentally that caterpillars of the gypsy moth, brown-tail moth, Orgyia antiqua and Spilarctia lubricipeda were not susceptible to infection when fed with the spores of Nosema bombicis, whereas caterpillars of the satin moth, oak processionary moth, Pieris brassicae and Gastropacha quercifolia were infected and died.

There were several papers on the biology of new or little studied Microsporidia [Nosema, sp. n., in cutworms (Euxoa segetum) (A. Huger, FRG), Perezia pyraustae in the corn-borer (Pyrausta nubilalis) (P. Kramer, USA), Crithidia fasciculata in mosquito larvae (P. Garnham, U. K.)] and several papers on nosematosis of the honey bee (J. Svoboda, Czechoslovakia; B. Dasgupta, India).

B. A. Astaurov, T. A. Bednyakova and V. N. Vereyskaya (USSR) presented a paper on thermal decontamination in vivo of bombyx eggs in cases of pebrine disease by heating the eggs for a short time in water and air. Only one paper was devoted to Nematoda—a description and biology of the new species (Necaplectana melolonthae on Melolontha vulgaris by J. Weiser (Czechoslovakia).

There was discussion on the activation, practical use and possibilities of improving the effectiveness of microsporidia and round worms for purposes of biological insect control. First experiments in that direction have proved hopeful. The use of helminths, as well as, and in particular, microsporidia for these purposes is no less promising than the use of the insects themselves. Weiser (Czechoslovakia) gave a review of the problems that must first be solved in this connection.

In the symposium on entomophage taxonomy papers touched mainly on the systematics and ecology of

Hymenoptera (four papers) and tachina flies (one paper). It was pointed out that the existing descriptions of Hymenoptera species were for the most part out of date. The use of parasites for biological control purposes made the need for more accurate determination of species an urgent necessity. Improved diagnostics were necessary and this now called for systematic re-examination of collections and types, with the revision of species descriptions, organized international co-operation for the revision of the most difficult groups and the preparation of a taxonomic catalogue of entomophages (Z. Boucek, Czechoslovakia).

There were individual papers on the taxonomy of Trichogrammatidae (N. A. Telenga, USSR), the biology of the tachina fly Mericia ampelus Wlk, a lackey moth (Malacosoma neustria) parasite (M. Tadic, Yugoslavia), the biology and effectiveness of the aphidine Diaeretus rapae (Curt.) on cabbage aphis (U. Sedlag, GDR) and the taxonomy of the subfamily of egg parasites Telenominae (L. Masner, Czechoslovakia). Masner had re-examined a large series of egg parasites from Hemiptera-Heteroptera and had come to the conclusion that almost all the species possessed great variability and were very difficult, sometimes practically impossible, to identify from the old keys and diagnoses; a complete revision was necessary and that required additional morphological research, field observation on the biology and ecology and, in a number of cases, ad hoc experiments.

The symposium on evaluation of the results of introduction consisted of four papers, one on the intra-area colonization of entomophages (I. A. Rubtsov, USSR), one on the effectiveness of introducing parasites of San Jose scale in Czechoslovakia (A. Guba, Czechoslovakia), one on the use of the biological method in forestry (V. Kelev, Poland) and one on the biology and possibility of using Meteorus versicolor for biological control of brown-tail moth and oak processionary moth (H. Fankhanel, GDR). The forms of Prospaltellae introduced into Czechoslovakia from the USSR and China were morphologically indistinguishable but biologically very different; the biological differences were clearly reflected in their effectiveness. Lindorus introduced into Czechoslovakia from the USSR wintered badly. An experiment in combined biological control of Acantholyda nemoralis is being carried out in Poland. The experiment consists of planting other tree species in a spruce forest, breeding boars and birds, introducing colonies of forest ants and propagating the parasitic nematod Neoaplectana janickii, combined with a limited use of insecticides.

Recommending intra-area colonization of Meteorus versicolor, Fankhanel believed it particularly important to eliminate hyper-parasites which reduced the effectiveness of the primary parasite. This could be done in practice by delaying the emergence of the secondary parasites for two weeks. More extensive introduction and acclimatization of entomophages would have to be achieved primarily by using species originating in Eurasia, since those possessed a high biotic potential. To improve the efficiency of this work, many-sided ecological and biological research on pests and their entomophages was essential and methods of collecting, preserving, introducing and transporting entomophages would have to be worked out. Introduction must be supplemented by intra-area settlement.

On the problem of increasing the efficiency of parasitic insects, nine papers were presented, all very different in character. The first two ("Some Considerations on the Use of Polyvalent Parasites and Predators for Biological Control" by L. P. Mesnil, Switzerland, and "Results of the Study and Use of Parasites and Predators in Pest Control in the USSR" by V. A. Shchepetil'nikov, USSR) were in the nature of reviews and contained a variety of data, most of which had been published before, on the theory and practice of the biological method. The contributions by V. V. Yakhontov (USSR) on improving the vitality of local entomophages by intra-species hybridization, by B. M. Chumakova (USSR) on San Jose scale predators, by V. A. Shapiro (USSR) on methods of cooperating with the activity of parasitic oligophages in forest plantations and by B. V. Ryvkin (USSR) on the entomophages of needle and leaf pests are also more or less known to Soviet entomologists.

W. Schwenke (GDR) compared the capacity of various parasites to adapt to the growth cycle of the host by diapausing; in a number of cases it has been shown that that parasite's diapause was induced by the host, with a consequent synchronization of growth periods, favorable to the parasite.

Observations by J. Sedivy (Czechoslovakia) showed that the reproduction of Charaeas graminis L. was controlled by the tachina fly Salmacia fasciata Mg. and Ichneumon bucculentus Wesm. The use of chemical preparations against the pest had reduced host infection by the parasites in the following year from 60-85 per cent to between 10 and 23 per cent, leading to a fresh rise in the pest population; the population low due to epizootic diseases usually occurred one year later than in foci which had not been chemically treated. It was very difficult to determine the effectiveness of aphis-eliminating predators; statistical methods had to be used (L. Weismann, Czechoslovakia). In the symposium on monophages and polyphages, the prevalent idea that specific monophages alone were of value was contradicted by Liu Chung-lo (Chinese People's Republic), who received support for the contention that oligophages were of no small value; most entomophages fell into this class. In a number of cases, polyphages (Trichogramma evanescens Westw. and Compsilura concinnata Mg.) proved in the long run even more useful than monophages.

A number of papers by Czechoslovak entomologists showed that they have been working intensively on investigating the biology and ecology of particular groups of entomophages: the Carabidae (V. Skuhravy), the Aphidiinae (P. Stary), the Coccinellidae (J. Hodek) and the complexes on sugar-beets (J. Hodek, J. Holman, P. Stary and P. Stys) and in forest plantations (S. Kolubaiv). The final purpose of these investigations was to discover the variation in pest species population and indicate ways of regulating the pest combinations by biological methods.

Interesting observations had been made by E. Novakova (Czechoslovakia) in the Krushny forests, where large-scale multiplication of the saw flies (Cephaleia abietis L. and C. arvensis Pz.) had been observed for a number of years. In regions where wild pigs, breaking through the forest undergrowth, were common the numbers of the caterpillar-like saw fly larvae had fallen, in places by 74 per cent (parasites destroyed 22-59 per cent). It has been found that the wild pigs rooted only in places where there was a sufficiently high density of these larvae in the surface litter under the trees.

The final symposium, on international cooperation, contained reports on the situation, problems and prospects for the development of biological control in Bulgaria (D. Stefanov), Poland (H. Sandner), Czechoslovakia (A. Kalandra), Slovakia (E. Arbatskaya) and Italy (G. Domenichini). J. Weisner, A. Guba, F. K. Simmonds, I. Franz and others spoke on forms of international cooperation in this field.

The conveners' and participants' views on aims and forms of international cooperation, together with the Resolution, have already been partially published in Russian (Entomologicheskoye obozreniye 38:262, 264).

The collection under review contains new and varied material on insect pathology and on entomophages and will undoubtedly be of lively interest to Soviet and foreign readers from many countries.

J. JEANNEL REVISION DES"TRECHINT"DU CAUCASE.

Mem. Mus. Nation Hist. Natur., ser.A, Zool.,XVII, 3:155-216, Paris, 1960

O. L. KRYZHANOVSKIY

Outside the Soviet Union there is very little contemporary entomological literature specifically devoted to the fauna of the USSR or particular regions of the USSR. This review of Carabidae of the tribe Trechini found in the Caucasus, written by the well-known French entomologist and zoogeographer, R. Jeannel, therefore attracts particular attention.

The Carabidae of this tribe are of considerable evolutionary and zoogeographical interest. With the exception of a few species they cover very small areas and form, particularly in mountainous countries, whole clusters of closely related but very distinct species; a study of the localities occupied by these species could provide important information on the faunal history of the regions concerned. On the other hand, the concealed way of life of the majority of Trechini, and the presence among them of a large number of highly specialized, often blind, cave or underground species, make it difficult to study these peculiar Carabidae, which require special methods of collection and investigation. For this reason the study of Trechini has in many regions scarcely begun. While they are already known in some detail in the Alps and the Carpathians, the Caucasus has remained relatively poorly studied from this point of view, although a good many species were described from various regions of that country in the 19th century and the beginning of the 20th by a number of authors, in particular M. Chodouard and E. Reutter and in 1927-1928 the known Caucasian species were revised by Jeannel himself, who published an extensive monograph on the Trechini, covering the whole world. This author has so far remained the greatest authority on this group.

Jeannel's new work is based on extensive, carefully labelled collections of Trechini sent to him for processing by V. N. Kurnakov, who had made a special collection of Carabidae over a number of years in many regions of the Bol'shoy and Malyy Caucasus and Transcaucasia, with particular attention to the Trechini. In addition, Jeannel has reexamined the species types described by Chodouard, which are now in the Paris Museum of Natural History; he had earlier had the opportunity of studying Reutter's types and in the course of his many years' work he has brought together in Paris a very considerable amount of material on Caucasian Trechini from various western European collections.

Jeannel's monograph is thus based on a large quantity of factual material and therefore deserves the attention of Soviet entomologists. The work deals with 54 species of Trechini belonging to 8 genera: 1 species of Perileptus, 1 Thalassophilus, 41 Trechus, 2 Duvalius, 1 Nannotrechus, 5 Cimmerites, 1 Meganophthalmus and 1 Jeannelius (the 1st four genera are endemic in the Caucasus). Of these, 15 species of Trechus, 1 Cimmerites and 1 Duvalius, together with a number of subspecies, are described by the author as new to science (most of them from Kurnakov's collection). The author has also corrected a number of mistakes which he had let pass in his first monograph; in particular he has reduced to synonyms two species which he had described earlier and has also made other synonymic comments. In addition, he has rewritten in detail the passages of the blind cave genera Meganophthalmus and Jeannelius, recently described by V. N. Kurnakov.

The text is excellently illustrated with numerous drawings.

Some of the author's zoogeographical conclusions, given at the end of the monograph, are interesting and we shall give a brief account of them. All the endemic species of Trechini are concentrated in the western and central parts of the Bol'shoy Caucasus and in the ridges of the Malyy Caucasus. Not one endemic species of this tribe is known either from the lowland region of Ciscaucasia or from the eastern part of the Bol'shoy Caucasus east of the Borbalo massif; the west Caucasus is particularly rich in endemics. Among the endemics it is possible to trace older species which are still isolated palaeogenetic forms and younger neogenetic species. The former include representatives of the genera Meganophthalmus, Jeannelius, Duvalius, Nannotrechus and Cimmerites as well as many of the genus Trechus, in particular from the groups T. gravidus and P. lederi; the latter include a number of other groups of the genus Trechus related to T. quadristriatus and T. subnotatus.

The close connections established by Jeannel between the high mountain Caucasian Trechus of the group T.lederi and Tyan'-Shan' species of this genus deserve particular attention. The author, somewhat controversially, derives these species from Angarida; but the presence of such connections is indeed highly interesting and analogies can be found in other groups of Coleoptera. Pterostichus (Myosodes) sodalicius Heyd., for example, from the western Tyan'-Shan', is quite unique among Central Asian fauna, yet is at the same time, closely related to the Dagestan P. (M). nivicola Men. and, through it, allied with other Caucasian species of this subgenus as well. Similar relationships are found among beetles of the genus Nastus.

Zoogeographical connections exist also between the Caucasus and Crimean mountain regions (Trechus liopleurus Chd., the distribution of which is restricted to these regions, and the blind cave-dwelling Caucasian genus Meganophthalmus, related to the Crimean Pseudaphaenops) and even with the southern Carpathians (Duvalius Duvalidius kurnakovi Jeann., which the author associates with species of this subgenus from the Carpathians). Jeannel explains these relationships by following Andrusov in postulating the existence in Middle Tertiary times of a Cimmerian ridge joining the western Caucasus to the Crimean mountains, and the latter to the Balkans and through them to the Carpathians.

Finally, connections between the Caucasus and the western parts of Asia Minor are noted.

Jeannel's contentions are in many ways controversial and the facts on which they are based permit of other explanations. Nevertheless, no investigator of the animal kingdom of the Caucasus and its history can proceed without these findings.

The most serious deficiency in Jeannel's work is that he has not made use of the extensive material on Caucasian Trechini in the Zoological Institute Academy of Sciences and other scientific institutions in the Soviet Union. Had he done so, his work would have been even more interesting and valuable.

RUSSIAN JOURNALS FREQUENTLY CITED

[Biological Sciences]

Abbreviation[1]	Journal[1]	Translation
Agrobiol.	Agrobiologiya	Agrobiology
Akusherstvo i Ginekol.	Akusherstvo i Ginekologiya	Obstetrics and Gynecology
Antibiotiki	Antibiotiki	Antibiotics
Aptechnoye Delo	Aptechnoye Delo	Pharmaceutical Transactions
Arkh. Anat. Gistol. i. Embriol.	Arkhiv Anatomii Gistologii i Embriologii	Archives of Anatomy, Histology, and Embryology
Arkh. Biol. Nauk SSSR	Arkhiv Biologicheskikh Nauk SSSR	Archives of Biological Science USSR
Arkh. Patol.	Arkhiv Patologii	Archives of Pathology
Biofizika	Biofizika	Biophysics
Biokhimiya	Biokhimiya	Biochemistry
Biokhim. Plovod i Ovoshchey	Biokhimiya Plovod i Ovoshchey	Biochemistry of Fruits and Vegetables
Bot. Zhur.	Botanicheskiy Zhurnal	Journal of Botany
Byull. Eksptl. Biol. i Med.	Byulleten' Eksperimentalnoy Biologii i Meditsiny	Bulletin of Experimental Biology and Medicine
Byull. Moskov. Obshchestva Ispytateley Prirody, Otdel Biol.	Byulleten' Moskovskogo Obshchestva Ispytateley Prirody, Otdel Biologicheskiy	Bulletin of the Moscow Naturalists Society, Division of Biology
Doklady Akad. Nauk SSSR	Doklady Akademii Nauk SSSR	Proceedings of the Academy of Sciences USSR
Eksptl. Khirurg.	Eksperimentalnaya Khirurgiya	Experimental Surgery
Farmakol. i Toksikol.	Farmakologiya i Toksikologiya	Pharmacology and Toxicology
Farmatsiya	Farmatsiya	Pharmacy
Fiziol. Rasteniy	Fiziologiya Rasteniy	Plant Physiology
Fiziol. Zhur. SSSR	Fiziologicheskiy Zhurnal SSSR im. I. M. Sechenova	I. M. Sechenov Physiology Journal USSR
Gigiyena i Sanit.	Gigiyena i Sanitariya	Hygience and Sanitation
Izvest. Akad. Nauk SSSR, Ser. Biol.	Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya	Bulletin of the Academy of Sciences USSR, Biology Series
Izvest. Tikhookeanskogo N. I. Inst. Rybnogo Khoz. i Okeanog.	Izvestiya Tikhookeanskogo N. I. Instituta Rybnogo Khozyaystva i Okeanografii	Bulletin of the Pacific Ocean Scientific Institute of Fisheries and Oceanography
Khirurgiya	Khirurgiya	Surgery
Klin. Med.	Klinicheskaya Meditsina	Clinical Medicine
Lab. Delo	Laboratornoye Delo (po Voprosam Meditsiny)	Laboratory Work (on Medical Problems)
Med. Parazitol.	Meditsinskaya Parazitologiya i Parazitarnye Bolezni	Medical Parasitology and Parasitic Diseases
Med. Radiol.	Meditsinskaya Radiologiya	Medical Radiology
Med. Zhur. Ukrain.	Medichniy Zhurnal Ukrainskiy	Ukrainian Medical Journal
Mikrobiologiya	Mikrobiologiya	Microbiology
Mikrobiol. Zhur.	Mikrobiologichniy Zhurnal	Microbiology Journal
Nevropatol. Psikhiat. i Psikhogig.	Nevropatologiya, Psikhiatriya i Psikhogigiyena	Neuropathology, Psychiatry and Psychohygiene
Ortoped., Travmatol. i Protez.	Ortopediya, Travmatologiya i Protezirovaniye	Orthopedics, Traumatology and Prosthetics
Parazitol. Sbornik	Parazitologicheskiy Sbornik	Parasitology Collection
Pediatriya	Pediatriya	Pediatrics
Pochvovedeniye	Pochvovedeniye	Soil Science
Priroda	Priroda	Nature
Problemy Endokrinol. i Gormonoterap.	Problemy Endokrinologii I Gormonoterapii	Problems of Endocrinology and Hormone Therapy
Problemy Gematol.	Problemy Gematologii i Perelivaniya Krovi	Problems of Hematology and Blood Transfusion
Problemy Tuberk.	Prolemy Tuberkuleza	Problems of Tuberculosis

[1] Board of Geographic Names Transliteration System.

Sovet. Med.	Sovetskaya Meditsina	Soviet Medicine
Sovet. Vrachebnyy Zhur.	Sovetskiy Vrachebnyy Zhurnal	Soviet Physicians Journals
Stomatologiya	Stomatologiya	Stomatology
Terap. Arkh.	Terapevticheskiy Arkhiv	Therapeutic Archives
Trudy Gelmint. Lab.	Trudy Gelmintologicheskoy Laboratoriya	Transactions of the Helminthology Laboratory
Trudy Inst. Genet.	Trudy Instituta Genetiki	Transactions of the Institute of Genetics
Trudy Inst. Gidrobiol.	Trudy Instituta Gidrobiologiya	Transactions of the Institute of Hydrobiology
Trudy Inst. Mikrobiol.	Trudy Instituta Mikrobiologiya	Transactions of the Institute of Microbiology
Trudy Inst. Okean.	Trudy Instituta Okeanologii. Akademii Nauk SSSR	Transactions of the Institute of Oceanology, Academy of Sciences, USSR
Trudy Leningrad. Obshchestva Yestestvoisp.	Trudy Leningradskogo Obshchestva Yestestvoispytateley	Transactions of the Leningrad Society of Naturalists
Trudy Vsesoyuz. Gidrobiol. Obshchestva	Trudy Vsesoyuznogo Gidrobiologicheskogo Obshchestva	Transactions of the All-Union Hydrobiological Society
Trudy Vsesoyuz. Inst. Eksptl. Med.	Trudy Vsesoyuznogo Instituta Eksperimental'noy Meditsiny	Transactions of the All-Union Institute of Experimental Medicine
Ukrain. Biokhim. Zhur.	Ukrainskiy Biokhimichniy Zhurnal	Ukrainian Biochemical Journal
Urologiya	Urologiya	Urology
Uspekhi Biokhimii	Uspekhi Biokhimii	Progress in Biochemistry
Uspekhi Sovremennoy Biol.	Uspekhi Sovremennoy Biologii	Progress in Contemporary Biology
Vestnik Akad. Med. Nauk SSSR	Vestnik Akademii Meditsinskikh Nauk SSSR	Bulletin of the Academy of Medical Science, USSR
Vestnik Khirurg. im. Grekova	Vestnik Khirurgii imeni Grekova	Grekov Bulletin of Surgery
Vestnik Leningrad. Univ. Ser. Biol.	Vestnik Leningradskogo Universiteta, Seriya Biologii.	Journal of the Leningrad University, Biology Series
Vestnik Moskov. Univ., Ser. Biol. i Pochvov.	Vestnik Moskovskogo Universiteta, Seriya Biologii i Pochvovedeniya	Bulletin of the Moscow University, Biology and Soil Science Series
Vestnik Oftalmol.	Vestnik Oftalmologii	Bulletin of Ophthalmology
Vestnik Oto-rino-laringol.	Vestnik Oto-rino-laringologii	Bulletin of Otorhinolaryngology
Vestnik Rentgenol. i Radiol.	Vestnik Rentgenologii i Radiologii	Bulletin of Roentgenology and Radiology
Vestnik Venerol. i Dermatol.	Vestnik Venerologii i Dermatologii	Bulletin of Venereology and Dermatology
Veterinariya	Veterinariya	Veterinary Science
Vinodeliye i Vinogradarstvo	Vinodeliye i Vinogradarstvo SSSR	Wine-Making and Viticulture
Voprosy Klin.	Voprosy Klinicheskiye	Clinical Problems
Voprosy Med. Khim.	Voprosy Meditsinskoy Khimii	Problems of Medical Chemistry
Voprosy Med. Virusol.	Voprosy Meditsinskoy Virusologii	Problems of Medical Virology
Voprosy Nevrokhirurg.	Voprosy Nevrokhirugii	Problems of Neurosurgery
Voprosy Onkol.	Voprosy Onkologii	Problems of Oncology
Voprosy Pitaniya	Voprosy Pitaniya	Problems of Nutrition
Voprosy Psikhologii	Voprosy Psikhologii	Problems of Psychology
Voprosy Virusologii	Voprosy Virusologii	Problems of Virology
Vrachebnoye Delo	Vrachebnoye Delo	Medical Profession
Zav. Lab.	Zavodskaya Laboratoriya	Factory Laboratory
Zhur. Mikrobiol., Epidemiol. i Immunobiol.	Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii	Journal of Microbiology, Epidemiology, and Immunobiology
Zhur. Nevropatol. i Psikhiat.	Zhurnal Nevropatologii i Psikhiatrii imeni S. S. Korsakova	S. S. Korsakov Journal of Neuropathology and Psychiatry
Zhur. Obshchey Biol.	Zhurnal Obshchey Biologii	Journal of General Biology
Zhur. Vysshey Nerv. Deyatel.	Zhurnal Vysshey Nervnoy Deyatel'nosti imeni I. P. Pavlova	I. P. Pavlov Journal of Higher Nervous Activity
Zool. Zhur.	Zoologicheskiy Zhurnal	Journal of Zoology

ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN RUSSIAN BIO-SCIENCES LITERATURE

Abbreviation (Transliterated)	Significance
AMN SSSR	Academy of Medical Sciences, USSR
AN SSSR	Academy of Sciences, USSR
BIN	Botanical Institute
FTI	Institute of Physiotherapy
GONTI	State Scientific Technical Institute
GOST	All-Union State Standards
GRRRI	State Roentgenology, Radiology, and Cancer Institute
GTTI	State Technical and Theoretical Literature Press
GU	State University
I Kh N	Scientific Research Institute of Surgical Neuropathology
IL (IIL)	Foreign Literature Press
IONKh	Inst. Gen. and Inorganic Chemistry (N. S. Kurnakov)
IP	Soil Science Institute (Academy of Sciences, USSR)
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd.	Press
LEM	Laboratory for experimental morphogenesis
LENDVI	Leningrad Institute of Dermatology and Venereology
LEO	Laboratory of Experimental Zoology
LIKhT	Leningrad Surgical Institute for Tuberculosis and Bone and Joint Diseases
LIPZ	Leningrad Institute for Study of Occupational Diseases
LIPK	Leningrad Blood Transfusion Institute
Medgiz	State Medical Literature Press
MOPISh	Moscow Society of Apiculture and Sericulture
MVI	Moscow Veterinary Institute
MZdrav	Ministry of Health
MZI	Moscow Zootechnical Institute
LOKhO	Leningrad Society of Orthopedic Surgeons
NIIZ	Scientific Research Institute of Zoology
NINKhI	Scientific Research Institute of Neurosurgery
NIU	Scientific Institute for Fertilizers
NIUIF	Scientific Research Institute of Fertilizers and Insecticides
NIVI	Veterinary Scientific Research Institute
ONTI	Division of the Scientific Technical Press
OTI	Division of Technical Information
RBO	Russian Botanical Society
ROP	Russian Society of Pathologists
SANIIRI	Central Asia Scientific Research Institute of Irrigation
SANIISh	Central Asia Scientific Research Institute of Sericulture
TsNII	All-Union Central Scientific Research Institute
TsNTL	Central Scientific and Technical Laboratory
VASKhNIL	All-Russian Lenin Academy of Agricultural Sciences
VIG	All-Union Institute of Helminthology
VIEM	All-Union Institute of Experimental Medicine
VIR	All-Union Institute of Plant Cultivation
VIUAA	All-Union Institute of Fertilizers, Soil Science, and Agricultural Engineering
VIZR	All Union Plant-Protection Institute
VNIRO	All-Union Scientific Institute of Fishing and Oceanography
ZIN	Zoological Institute (Academy of Sciences, USSR)

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. — Editor.